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Mercury Residues in Fish From Twenty-Four Lakes and Rivers in Alberta

Alberta
ENVIRONMENTAL CENTRE

87-00474/

MERCURY RESIDUES IN FISH FROM TWENTY-FOUR LAKES AND RIVERS IN ALBERTA

ALBERTA ENVIRONMENTAL CENTRE
VEGREVILLE, ALBERTA
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SUMMARY

This report describes methyl mercury and total mercury levels in fish collected from 24 lakes and rivers in Alberta during 1984. Analysis was conducted using a mercury hollow cathode lamp emitting monochromatic light. As part of quality assurance, the laboratory participated in a Canada-wide interlaboratory program administered by the Regional Chemist, Fisheries and Oceans Canada (Winnipeg). In addition, a number of blind samples, obtained from the Regional Chemist, were analyzed during the course of the investigation. Complete intra-laboratory quality control was maintained throughout the analysis for accuracy, precision and recovery.

For each species, total mercury content was regressed against fork length, and then the upper 95% confidence limit was calculated. If the mean and 95% confidence limits were below the standard for commercially marketed fish (0.5 parts per million or ppm) at all fish lengths, unlimited consumption was recommended. If either fell between 0.5 and 1.0 ppm, the recommendation was made that consumption be limited to no more than 10 meals per week. Between 1.0 and 1.5 ppm, consumption should be limited to only one meal per week. Because of the sensitivity of the developing fetus to mercurials, pregnant women should not consume fish containing more than 0.5 ppm.

A summary of the recommended consumption limits for the lakes and rivers under investigation is given below:

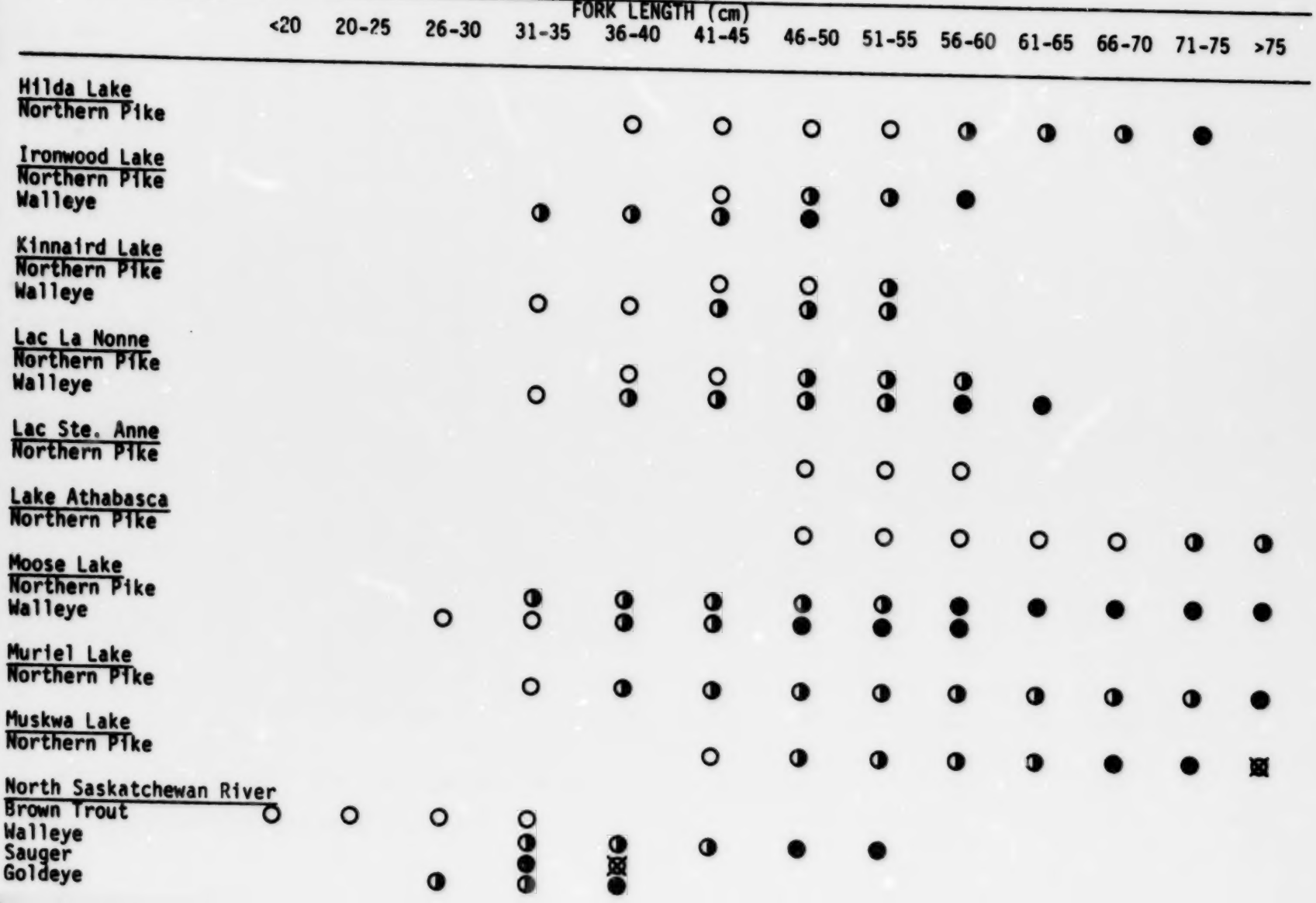
SUMMARY OF RECOMMENDED CONSUMPTION LIMITS:

○ UNLIMITED CONSUMPTION; ◑ 10 MEALS PER WEEK; ● ONE MEAL PER WEEK; ⊠ NONE

	FORK LENGTH (cm)												
	<20	20-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	>75
Athabasca River													
Northern Pike			○	○	○	○	○	◑	◑				
Walleye			◑	◑	◑	◑	●						
Goldeye			○	○	○	○	○						
Lake Whitefish				○	○	○	○						
Brintnell Lake													
Northern Pike							◑	◑	◑	◑			
Christina Lake													
Northern Pike							○	○	◑	◑	◑	●	●
Dickson Dam													
Northern Pike						◑	◑	◑					
Mountain Whitefish	○	○	○	○									
Burbot		○	○	○	○	○	○	○	○				
Longnose Sucker		○	○	○	○								
White Sucker			○	○	○								
Dried Meat Lake													
Northern Pike				○	○	○	○	○	○				
Elinor Lake													
Northern Pike					○	○	◑	◑					
Graham Lake													
Northern Pike						○	○	○	○	○	○	○	
Walleye	○	○	○	○	◑	◑	◑						
Helena Lake													
Northern Pike								○	○	◑	◑		
Walleye							◑	◑	◑				

SUMMARY OF RECOMMENDED CONSUMPTION LIMITS (Continued):

○ UNLIMITED CONSUMPTION; ◑ 10 MEALS PER WEEK; ● ONE MEAL PER WEEK; ⊠ NONE



SUMMARY OF RECOMMENDED CONSUMPTION LIMITS (Continued):

○ UNLIMITED CONSUMPTION; ◑ 10 MEALS PER WEEK; ● ONE MEAL PER WEEK; ⊠ NONE

	FORK LENGTH (cm)											
	<20	20-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	>75
Pine Lake													
Northern Pike						○	○	○	◑	◑	◑	◑	◑
Round Lake													
Northern Pike						○	○	○	○	◑	◑	◑	
Smoky River													
Longnose Sucker		○	○	◑	◑	◑	●						
Wapiti River													
Longnose Sucker			○	◑	◑	⊠							
Whitefish Lake													
Northern Pike					◑	◑	◑	◑	◑	◑	◑		
Walleye				◑	◑	◑	●						

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1. INTRODUCTION

1.1 General

Mercury is a ubiquitous metal which is an enzyme and protein inhibitor. The chemical behavior of mercury characteristically results in high affinity towards thiol groups and enhanced covalency compared to its zinc counterpart. This causes increased *in vivo* uptake, transport and toxicity of mercurials. In surface waters, the primary sink for mercury is bottom sediments. The concentration of mercury depends on the surface area of sediment particles as well as organic content, cation exchange capacity and grain size. Desorption is a slow process and, in many cases, is negligible. Thus, in the event of untoward discharge of mercury, sediments may be contaminated for many years.

Environmental mercury may exist in a number of forms. From a toxicologic point of view, organic mercury is considered most important. Organic mercury can be divided into two categories: (i) that in which mercury is amphiphilic attached to one organic radical by a covalent bond and to an inorganic anion through an electrovalent bond; (ii) that in which mercury is liphophilic, attached to two organic radicals. In this case, both are covalently bonded.

Mercury in sediments and water exists mainly in inorganic forms. Methylating bacteria are, however, present in sediments, resulting in the conversion of inorganic mercury to organic

mercury. It is this latter form which is readily concentrated in biological tissues. Depending on environmental conditions, from 50 to 95% of mercury in fish tissues exists in the organic form. Organic mercury is many times more toxic than inorganic mercury (Nriagu, 1979). In developing consumption standards, it is assumed that all of the mercury in fish exists in the organic form.

Although mercury levels in Alberta fish had been periodically measured throughout the 1970's, the first comprehensive work, on the North Saskatchewan River, was completed in 1983 (AEC, 1983). In that study, it was shown that northern pike Esox lucius, walleye Stizostedion vitreum, sauger Stizostedion canadense and goldeye Hiodon alosoides contained mercury residues in the 0.4 to 0.6 ppm range. Subsequent studies on the South Saskatchewan River, Red Deer River, Oldman River and Bow River have similarly shown that these species contain residues which exceed 0.5 ppm (AEC, 1984). Because mercury is therefore widely distributed in Alberta fish, a more comprehensive investigation was initiated in 1984. A total of 24 lakes and rivers was studied (Table 1). A site was selected for at least one of the following reasons:

1. Popular angling area
2. Suspected high mercury levels in fish, based on previous data from commercial catches
3. Newly formed reservoir
4. Commercial fishery
5. Major source of food for local inhabitants

1.2 Consumption Guidelines

In Canada, there is a federal guideline of 0.5 ppm (mg/kg) for commercially marketed fish. This is often taken as a maximum consumption standard for fish caught by angling. Fish containing between 0.5 and 1.0 ppm may be consumed in limited amounts whereas consumption of fish with more than 1.0 ppm is generally discouraged (MOE, 1984-85). Because the developing fetus retains more mercury than adults, pregnant women should not consume fish with more than 0.5 ppm mercury. The same restriction generally applies to young children. In the USA, a consumption guideline of 1.0 ppm is generally applied, whereas guidelines as low as 0.4 ppm have been used in Scandinavia. In all cases, the guidelines are well below the concentrations (>10 ppm) known to induce symptoms of mercury poisoning following the consumption of tainted fish (Nriagu, 1979). Thus administrators and policy makers have some flexibility in developing consumption recommendations.

For the purposes of this report, the total mercury content was regressed against fork length, and then the upper 95% confidence limit was calculated. If the mean and 95% confidence limits were below the standard for commercially marketed fish (0.5 ppm) at all fish lengths, unlimited consumption was recommended. If either fell between 0.5 and 1.0 ppm, the recommendation was made that consumption be limited to no more than 10 meals per week. Between 1.0 and 1.5 ppm, consumption should be limited to only one meal per week. Because of the sensitivity of the developing fetus to

mercurials, pregnant women should not consume fish containing more than 0.5 ppm.

2. MATERIALS AND METHODS

2.1 Collection of Fish

Although most fish were collected by gill net, samples were also taken by angling, electroshocking and seine net. In general, specimens were frozen within 5 h of capture at -20°C. Immediately prior to analysis, the fish were thawed at room temperature and a sample of muscle (250 g) dissected. In each species, the muscle was taken from the dorsal area between the head and dorsal fin. In a few cases, only heads were available for analysis. Tissues were taken from the dorsal area between the gill openings and cranium.

2.2 Chemical Analysis

Apparatus:

a. LDC (Laboratory Data Control, U.S.A.) Mercury Monitor equipped with a mercury hollow cathode lamp emitting monochromatic light at 253.7 nm.

b. Long path dual gas cell assembly (30 cm long and 0.75 cm diameter) made of rigid PVC with quartz lens windows at both ends.

c. Chart recorder.

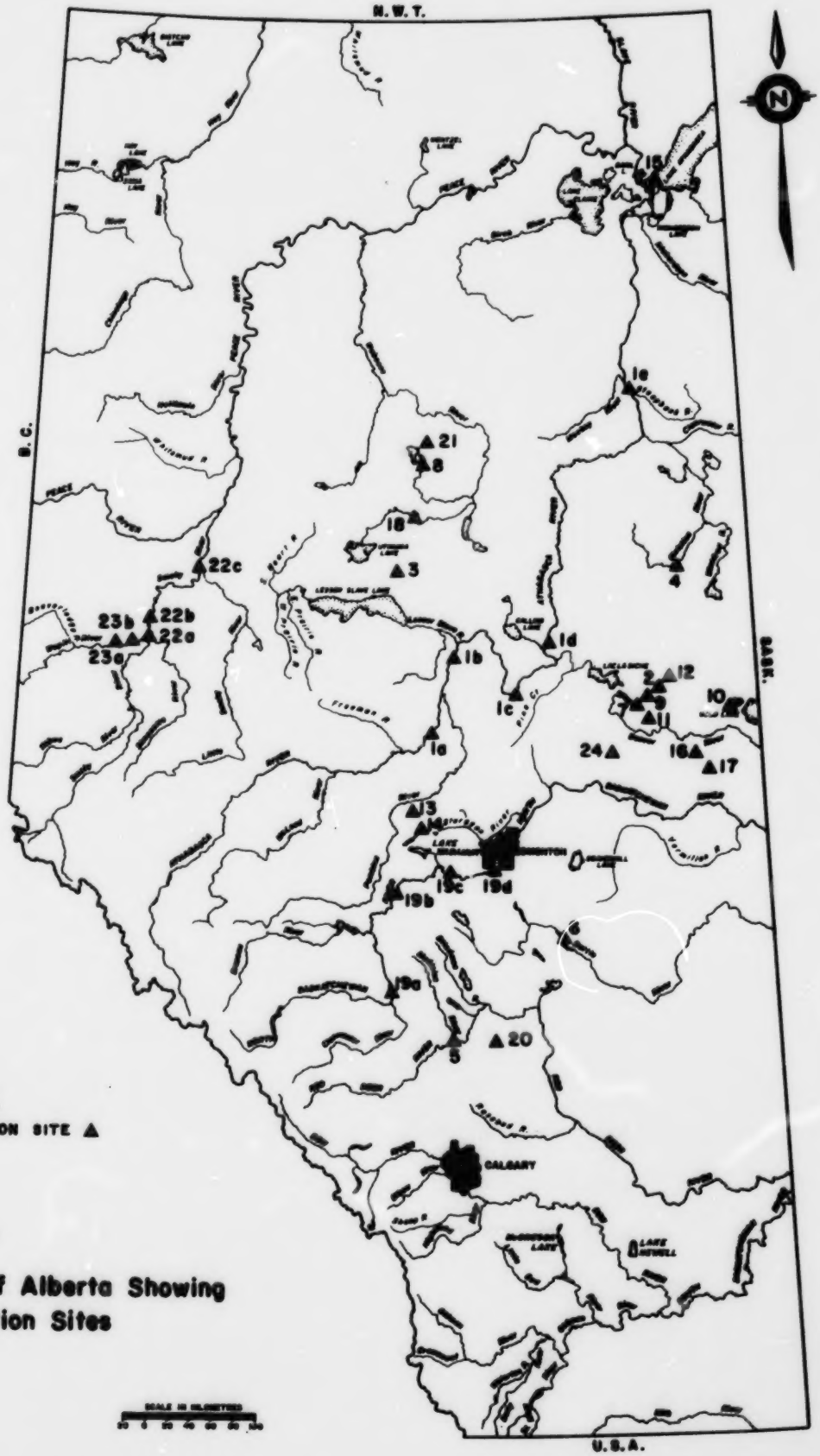
d. Specially designed and constructed pyrex glass mercury reduction-bubbler assembly.

Table 1. LAKES AND RIVERS UNDER INVESTIGATION.

River/Lake	Location (Latitude, Longitude)	
1. Athabasca River		
- Athabasca Bridge	54° 44'	113° 17'
- Calling River	55° 06'	112° 48'
- Hondo Bridge	55° 04'	114° 06'
- downstream of Suncor	57° 01'	111° 29'
- Klondyke Ferry	54° 01'	114° 29'
2. Blackett Lake	54° 44'	111° 35'
3. Brintnell Lake	55° 48'	114° 43'
4. Christina Lake	55° 37'	110° 55'
5. Dickson Dam	52° 02'	114° 14'
6. Dried Meat Lake	52° 52'	112° 45'
7. Elinor Lake	54° 40'	111° 39'
8. Graham Lake	56° 33'	114° 33'
9. Helena Lake	54° 41'	111° 35'
10. Hilda Lake	54° 31'	110° 26'
11. Ironwood Lake	54° 36'	111° 31'
12. Kinnaird Lake	54° 47'	111° 31'
13. Lac La Nonne	53° 57'	114° 18'
14. Lac Ste. Anne	53° 43'	114° 25'

Table 1. LAKES AND RIVERS UNDER INVESTIGATION.

River/Lake	Location (Latitude, Longitude)	
15. Lake Athabasca	58° 40'	111° 00'
16. Moose Lake	54° 15'	110° 49'
17. Muriel Lake	54° 08'	110° 40'
18. Muskwa Lake	56° 08'	114° 37'
19. North Saskatchewan River		
- Drayton Valley	53° 13'	114° 55'
- Rocky Mountain House	52° 23'	114° 57'
- Devon	53° 22'	113° 46'
- Genesee	53° 23'	114° 17'
20. Pine Lake	52° 05'	113° 26'
21. Round Lake	56° 45'	114° 34'
22. Smoky River	55° 08'	118° 18'
	55° 14'	118° 15'
	55° 43'	117° 38'
23. Wapiti River	55° 04'	118° 37'
	50° 03'	119° 07'
24. Whitefish Lake	54° 22'	111° 55'



Figure

Map of Alberta Showing Collection Sites

Map Code

Site #	Lake/River	Site Name
1	Athabasca River	
1a		Klondyke Ferry
1b		Hondo Bridge
1c		Athabasca Bridge
1d		Calling River
1e		Downstream of Suncor
2	Blackett Lake	
3	Brintnell Lake	
4	Christina Lake	
5	Dickson Dam	
6	Dried Meat Lake	
7	Elinor Lake	
8	Graham Lake	
9	Helena Lake	
10	Hilda Lake	
11	Ironwood Lake	
12	Kinnaird Lake	
13	Lac La Nonne	
14	Lac Ste. Anne	
15	Lake Athabasca	

Map Code (continued)

Site #	Lake/River	Site Name
16	Moose Lake	
17	Muriel Lake	
18	Muskwa Lake	
19	North Saskatchewan River	
19a		Rocky Mountain House
19b		Drayton Valley
19c		Genesee
19d		Devon
20	Pine Lake	
21	Round Lake	
22	Smoky River	
22a	Smoky River	confluence of Wapiti River
22b		Benzanson
22c		Watino Crossing
23	Wapiti River	
23a		Wembley
23b		Northern Alberta Railway Bridge
24	Whitefish Lake	

e. Pure nitrogen gas source (Standard cylinder) with two-stage exit regulator for constant gas delivery at low flow rate.

f. Constant temperature shaker bath with gable cover, platform and clips to hold 20 or more glass digestion tubes, with a total capacity of 24-35 litres of water.

g. Millimatic dispensers.

h. Pipetman and disposable tips.

i. Stop watch.

j. Magnetic stirrer.

k. Homogenizer; Sorvall Omni-mixer, Polytron PT10 or standard electrical blender with special mini-blending jars.

Method:

a. Sample preparation:

About 15 g of fish muscle tissue free from bone and fat was blended with 7.5 ml of 0.1N H_2SO_4 in a stainless blending cup till a smooth paste was obtained. Some fish like goldeye required only 5.0 ml of 0.1N H_2SO_4 due to a higher water content. Usually 30 seconds of blending time was sufficient to produce a homogeneous paste.

The wet homogenate (1 g) was weighed accurately into four digestion tubes. One aliquot was weighed into a petri dish and left loosely capped in a forced-air oven for 24 h at 55°C to determine the wet/dry weight ratio. If a delay (more than 1 day) in the analysis was anticipated, the aliquots were stored at -20°C in sealed polypropylene cups.

b. Sample digestion:

1. To two of the four aliquots in the digestion tubes, the following digestion mixture was added; 1 ml of 20% NaCl solution, 1 ml of 1% cysteine solution and 10 ml of 16N H_2SO_4. The tubes were tightly stopped in a shaker water bath at 55-60°C for 1 hr. Thorough mixing was ensured by adjusting the shaking speed. If the samples were not completely dispersed after 1 h, they were shaken for an additional 0.5 h. The tubes were then removed from the bath and cooled to room temperature. The sides and the stopper of the tubes were rinsed down with minimum d.d.w. (distilled deionized water) and made up to a known volume. The digested solutions were analyzed within 24 h.

2. To the remaining two aliquots in the digestion tubes, 5 ml of the digestion acid mixture (100 ml of conc. HNO_3 + 400 ml of conc. H_2SO_4) was added. The tubes were stoppered tightly, fitted into a rack and shaken in a water bath at 55-60°C for 2 h or until a clear solution is obtained. The tubes were removed from the bath and cooled to room temperature. 15 ml of 6% $KMnO_4$ solution was added slowly and allowed to stand for 30 min. If the purple color disappeared at this stage, more $KMnO_4$ was added till the color persisted. Then 30% H_2O_2 solution was added with caution while stirring until the precipitate just dissolved. The solutions were made to a

known volume and mixed well. The solutions were analyzed within 24 h.

c. Calibration and analysis:

Stock (100 mg/l) intermediate (220 µg/L) and working standard solutions (0.1 - 1.0 µg/l) of inorganic mercury ($HgCl_2$) and total mercury ($HgCl_2$ and CH_3HgCl) were prepared. Further data on standards and calibration curves are given in AEC (1983).

Inorganic mercury analysis

i) 15 ml of inorganic mercury standard was pipetted into the digestor-analysis tube.

ii) 1 ml of 20% NaCl solution, 1 ml of 1% cysteine solution and 3 ml of 16N H_2SO_4 were added to the standard.

iii) The tube was placed in position with the bubbler and flushed with N_2 gas to remove any interfering vapors.

iv) 1 ml of $SnCl_2/NH_2OH$ solution and 2 ml of 45% NaOH solution was added in quick succession.

v) After 30 seconds (using a stop watch) the mercury vapor produced was flushed by pure N_2 gas into the Mercury Monitor and the peak absorbance was recorded.

vi) When the absorbances began to decline, the 4-way valve was turned into the bypass position and the bubbler tube was rinsed off.

vii) The next standard solution was analyzed following steps (i) to (vi).

viii) The blanks (all reagents except mercury) are analyzed as above to detect any blank interference.

ix) Digested blanks and standards are also analyzed to detect any artifact introduced during digestion stage.

x) All the samples digested for inorganic mercury analysis (sample digestion (1)) were analyzed following steps (i) to (vi).

Total mercury analysis

i) Exactly 15 ml of total mercury standard solution is pipetted into a digestor-analysis tube.

(1) 5 ml of the digestion acid mixture (con. HNO_3 + conc. H_2SO_4, 1:4 ratio) was added to the standard solution.

(2) The tubes were stoppered tightly, fitted into a rack and shaken in a water bath at 55-60°C for 2 h or until a clear solution was obtained.

(3) The tubes were removed from the bath and cooled to room temperature.

(4) 15 ml of 6% w/v $KMnO_4$ solution was added and allowed to stand for 30 min. If the purple color disappeared, more $KMnO_4$ solution was added till the color persisted.

(5) A solution of 30% H_2O_2 was added cautiously with stirring until the precipitate just dissolved.

(6) The solution was made up to a known volume and mixed thoroughly.

(7) The total mercury was analyzed by following the steps (iii) to (ix) as described under (d) for inorganic mercury analysis.

(8) All the samples digested for total mercury analysis (sample digestion (2) were analyzed following steps (4) to (7) as described above.

d. Calculations:

After correcting for blank readings, if any, the calibration curves for inorganic and total mercury were prepared by plotting the peak heights versus the amount of Hg. The sample peak heights were compared with the respective calibration curves to determine the inorganic and total mercury concentrations. The differences between the inorganic and total mercury for the given sample is its methylmercury content. The amount of Hg per gram (wet weight) is given by:

$$\frac{\text{Amount of Hg (inorganic/methyl), } \mu g}{\text{wet weight of subsample}}$$

*Since acid is added during homogenization of the tissue, the aliquoted wet weight was corrected to arrive at the true wet weight of the fish tissue in the sample. For example, when aliquots were taken from a homogenate of 15 g of muscle tissue and 7.5 g of 0.1N H_2SO_4, the correction factor was 0.67. That is, every 1 g of wet aliquot contained only 0.67 g of wet fish tissue.

2.3 Quality Control and Assurance

2.3.1 Quality Control

In addition to vigorous implementation of good laboratory practices regarding reagents glassware, plasticware, maintenance of equipment, etc., routine quality control checks were made on the nanopure water, reagent(s) blank and the analytical detection system including the lamp intensity. For every sample, total mercury and inorganic mercury were analysed in duplicate. Thus ten fish generated forty samples for Hg analysis and each batch of 40 samples included two internal check standards. In addition, one mid-calibration standard for every 10 samples was analysed as a quality control check during analysis.

2.3.2 Quality Assurance

In addition to routine intra-laboratory quality control checks, the laboratory participates year-round in the National Interlaboratory Mercury in Fish Quality Assurance Program, conducted four times a year by the Federal Department of Fisheries and Oceans, Winnipeg, Canada (Appendix I). The participation began in 1982 when the mercury analysis commenced in Aquatic Biology Group, AEC and its performance was satisfactory.

2.4 Statistical Analysis and Interpretation of Data

The mean concentration of methyl mercury and total mercury for each species from the twenty-four lakes and rivers was initially determined. The relationship between mercury levels and growth parameter of fish was studied by regression analysis. Since mercury levels are known to increase with fish age and size, the residue data were then regressed against fish fork length. Fork length was selected as the independent variable because it is easier to measure by fishermen than age or weight.

Preliminary analysis of data showed that both mercury residues and length of fish did not satisfy the assumption of homogenity of variances and therefore these two variables were transformed to a logarithmic scale. This has the effect of increasing normality and decreasing skewness in the data. In addition, effects which are multiplicative on the original scale of measurement become additive on the logarithmic scale.

The model used in this study was $Hg = aL^{b}c$, which after logarithmic transformation could be analysed by linear regression in the following form:

$$\text{Log } Hg = \text{Log } a + b \text{ Log } L + \text{Log } c.$$

where Hg is the absolute quantity of mercury in each fish, a is the intercept, b is the regression coefficient or slope, L is the length of a fish, and c is the random error term associated with each measurement.

Prior to analysis, all mercury residue data were converted to absolute quantity of mercury on a per fish basis by multiplying concentration (µg/kg) by fish weight (kg). This permitted the expression of the data as an absolute quantity of mercury in each fish (µg/fish).

Analyses were also performed to test for the homogenicity of regression coefficients among lakes and fish species. This was done to find out if lakes and/or species could be pooled to increase the sample size in order to reduce the standard error of the regression coefficients. Results showed that overall regression coefficients were heterogenous among lakes and species and therefore pooling of the data was not done.

The empirical relationship between fish consumption and mercury concentration in a fish of given length was derived by using the 95% confidence limit of the regression line. The upper confidence limit was chosen to derive guidelines for consumption because it provides a relatively greater safety margin than use of mean data. Due to the symmetric nature of the confidence limits, one can easily derive the lower 95% confidence limit, if so desired. The confidence limits presented are valid for all fish lengths that were observed in this study. These values are presented for fish lengths in increments of 5 cm each. This increment value was selected because it could be easily distinguished by a fisherman and because of the biconcave nature of the confidence belt. As confidence limits are wider away from the mean than at the mean, a class size larger than 5 cm would have

introduced bias in resulting estimates. If the mean and upper 95% confidence limit were below 0.5 ppm at all fish lengths, unlimited consumption of fish was recommended. If either variable fell between 0.5 and 1.0 ppm, then the recommendation was made that consumption be limited to 10 meals per week. Between 1.0 and 1.5 ppm, consumption should be limited to one meal per week. Pregnant women, and children under the age of 15 years, should only consume fish with residues below 0.5 ppm. Since mercury residues depend on fish size, limitations placed on consumption often changed with the length of fish.

3. RESULTS

3.1 Athabasca River

A total of nine species of fish was collected from the Athabasca River (Table 2). Highest methyl mercury residues were found in walleye averaging 321 µg/kg (0.321 mg/kg or ppm), followed by northern pike at 195 µg/kg (Appendix II). Average levels in the other species ranged from only 45 to 172 µg/kg.

Based on log-log regression analysis, the mean concentration of mercury in a 30 cm walleye was 234 µg/kg, increasing to 428 µg/kg in a 50 cm fish (Table 3). The corresponding range in the upper 95% confidence limit was 575-1038 µg/kg (Table 4). Using the standard of 500 µg/kg (0.5 mg/kg), consumption of fish in the 30-45 cm range should be limited to 10 meals per week. In longer fish,

consumption should be one meal per week. Residues in northern pike were lower at all lengths in comparison to walleye (Tables 3 and 4). In fact, the upper 95% confidence limit exceeded 500 µg/kg in only the largest fish (>55 cm). Lake whitefish and goldeye were safe for consumption regardless of length (Tables 3 and 4).

Table 2. AVERAGE MERCURY LEVELS IN FISH FROM THE ATHABASCA RIVER.

	Concentration µg/kg	
	Methyl Hg	Total Hg
Northern Pike	195	235
Goldeye	172	211
White Sucker	81	120
Longnose Sucker	133	178
Flathead Chub	101	150
Walleye	321	364
Arctic Grayling	103	143
Rocky Mountain Whitefish	45	86
Lake Whitefish	49	81

Table 3. RELATIONSHIP BETWEEN TOTAL MERCURY (µg/fish) AND FORK LENGTH (cm) IN FISH FROM THE ATHABASCA RIVER.

(i)	Goldeye	log Hg = -2.5856 + 2.9893 log L (r=0.69) N = 22
(ii)	Walleye	log Hg = -4.6238 + 4.3720 log L (r=0.88) N = 24
(iii)	Northern Pike	log Hg = -5.8182 + 4.8167 log L (r=0.98) N = 13
(iv)	Lake Whitefish	log Hg = -7.9901 + 6.1780 log L (r=0.94) N = 10

Table 4. MEAN TOTAL MERCURY (µg/kg), AND UPPER 95% CONFIDENCE LIMIT, IN FISH OF DIFFERENT LENGTH FROM THE ATHABASCA RIVER.

Walleye						
Length (cm) =		30	35	40	45	50
Mean Hg =		234	281	329	379	428
U95% CL Hg/MBW (Mean Body Weight)=		575	666	772	895	1038
N = 24						
Northern Pike						
Length (cm) =	30	40	45	50	55	60
Mean Hg =	113	181	220	261	306	353
U95% CL Hg/MBW =	233	329	394	474	571	902
N = 13						
Lake Whitefish						
Length (cm) =			35	40	45	50
Mean Hg =			53	86	131	190
U95% CL Hg/MBW =			86	135	221	359
N = 10						
Goldeye						
Length (cm) =		30	35	40	45	50
Mean Hg =		216	195	178	165	153
U95% CL Hg/MBW =		441	392	375	375	383
N = 22						

3.2 Dickson Dam (Glennifer Lake)

A total of seven species of fish was caught in the reservoir (Appendix VI). Residues in all species averaged <300 µg/kg as indicated below:

Species	Methyl Mercury (µg/kg)	Total Mercury (µg/kg)
Rocky Mountain Whitefish (N=20)	133	166
Burbot (N=11)	231	269
Rainbow Trout (N=1)	160	181
Brown Trout (N=1)	5	43
Longnose Sucker (N=20)	155	187
White Sucker (N=20)	96	137
Northern Pike (N=20)	242	273

The highest single value (449 µg/kg) was for a northern pike measuring 51.9 cm in length.

The log-log regressions of the five most frequently captured fish are listed in Table 5. In the case of Rocky Mountain whitefish, burbot, longnose sucker and white sucker, residues were always below 500 µg/kg at the upper 95% confidence limit (C.L.). However, the 95% C.L. of northern pike exceeded 500 µg/kg at all lengths (Table 6) requiring a consumption limit of 10 meals per week to be placed on this species.

TABLE 5. RELATIONSHIP BETWEEN TOTAL MERCURY (µg/fish) AND FORK LENGTH (cm) IN FISH FROM GLENNIFER LAKE (DICKSON DAM).

(i)	Rocky Mountain Whitefish N = 20	log Hg = -2.5933 + 2.8493 log L (r = 0.68)
(ii)	Burbot N = 11	log Hg = -3.7957 + 3.6015 log L (r = 0.99)
(iii)	Longnose sucker N = 20	log Hg = -4.8620 + 4.4766 log L (r = 0.94)
(iv)	Northern Pike N = 20	log Hg = -1.6062 + 2.9906 log L (r = 0.57)
(v)	White Sucker N = 20	log Hg = -3.8536 + 3.7557 log L (r = 0.94)

TABLE 6. MEAN TOTAL MERCURY LEVEL (µg/kg) AND UPPER 95% CONFIDENCE LIMIT IN FISH FROM GLENNIFER LAKE (DICKSON DAM).

Rocky Mountain Whitefish							
Length (cm) =						30	35
Mean Hg =						142	140
U 95% CL Hg/MBW =						444	486
N = 20							
Burbot							
Length (cm) =	20	30	40	45	50	55	60
Mean Hg =	185	223	249	262	274	286	296
U 95% CL Hg/MBW =	333	367	394	413	433	455	476
N = 11							
Longnose Sucker							
Length (cm) =				20	30	35	40
Mean Hg =				85	152	190	230
U 95% CL Hg/MBW =				167	251	313	384
N = 20							
White Sucker							
Length (cm) =				20	30	35	40
Mean Hg =				105	129	140	149
U 95% CL Hg/MBW =				172	190	207	224
N = 20							
Northern Pike							
Length (cm) =				40	45	50	55
Mean Hg =				278	275	271	269
U 95% CL Hg/MBW =				64	535	511	525
N = 20							

3.3 Dried Meat Lake

Only northern pike were collected from Dried Meat Lake (Appendix VII). A total of 30 specimens was analyzed. The average methylmercury concentration was 130 µg/kg with a range of 52-211 µg/kg. Total mercury averaged 161 µg/kg (range 99-235 µg/kg).

The mercury-length regression for northern pike is:

$$\log Hg = -3.8355 + 3.5666 \log L \quad (r = 0.90)$$

Based on this regression, mean mercury concentrations ranged from 105 to 219 µg/kg at fish lengths of 30 and 60 cm respectively. The corresponding upper 95% confidence limit for these lengths were 188 and 387 µg/kg respectively, as outlined below:

Northern Pike Length (cm) =	30	35	40	45	50	55	60
Mean Hg ppb =	105	124	143	161	180	200	219
U 95% CL Hg/MBW =	188	214	243	274	309	347	387
N = 30							

3.4 Lakes in the North East Region

Walleye and northern pike were sampled from most of these lakes (Appendices III-V, VIII-XIX, XXI, XXII, XXV). Average methyl mercury and total mercury residues are listed below:

	WALLEYE			NORTHERN PIKE		
	METHYL MERCURY (µg/kg)	TOTAL MERCURY (µg/kg)	SAMPLE SIZE	METHYL MERCURY (µg/kg)	TOTAL MERCURY (µg/kg)	SAMPLE SIZE
Blackett Lake	No data	No data	0	156	242	4
Brintnell Lake	No data	No data	0	267	314	10
Christina Lake	No data	No data	0	218	268	8
Elinor Lake	269	315	2	255	333	10
Graham Lake	71	152	10	71	131	10
Helena Lake	399	468	10	279	339	10
Hilda Lake	No data	No data	0	255	343	10
Ironwood Lake	411	464	7	339	392	10
Kinnaird Lake	196	268	10	296	343	10
Lac La Nonne	363	423	10	165	209	10
Lac Ste. Anne	62	102	10	99	158	10
Lake Athabasca	No data	No data	0	219	288	10
Moose Lake	337	385	10	203	282	11
Muriel Lake	No data	No data	0	263	359	12
Muskwa Lake	No data	No data	0	372	461	10
Pine Lake	No data	No data	0	201	276	6
Round Lake	132	184	5	150	230	10
Whitefish Lake	268	331	9	299	321	10

Although the mean for both species was always below 500 µg/kg, residues in some lakes such as Helena Lake, Ironwood Lake and Muskwa Lake approached this level. In addition, some large specimens carried burdens of well over 500 µg/kg (see Appendices).

The log-log regression equations relating mercury residues to fish length are given in Table 7. In the majority of lakes in the northeast region, residues in northern pike increase with length to the point where the 95% confidence limit exceeds 500 µg/kg (Table 8). The same applies to walleye. Fish bearing highest residues in the area were from Moose Lake, Muskwa Lake and Ironwood Lake.

TABLE 7. RELATIONSHIP BETWEEN TOTAL MERCURY (µg/fish) AND FORK LENGTH (cm) IN FISH FROM LAKES IN THE NORTHEAST REGION OF ALBERTA.

Brintnell Lake			
	Northern pike	log Hg = -1.2008 + 2.1918 log L	(r = 0.53)
	N = 10		
Christina Lake			
	Northern pike	log Hg = -8.0666 + 6.0321 log L	(r = 0.96)
	N = 8		
Elinor Lake			
	Northern pike	log Hg = -5.4881 + 4.8613 log L	(r = 0.96)
	N = 10		
Graham Lake			
i	Northern pike	log Hg = -3.3842 + 3.1923 log L	(r = 0.84)
	N=10		
ii	Walleye	log Hg = 0.6577 + 0.9555 log L	(r = 0.81)
	N = 10		
Helena Lake			
i	Northern pike	log Hg = -6.2768 + 5.1064 log L	(r = 0.90)
	N = 10		
ii	Walleye	log Hg = -0.3382 + 1.9251 log L	(r = 0.67)
	N = 10		
Hilda Lake			
	Northern pike	log Hg = -6.2423 + 5.1160 log L	(r = 0.98)
	N = 10		

TABLE 7. RELATIONSHIP BETWEEN TOTAL MERCURY (µg/fish) AND FORK LENGTH (cm) IN FISH FROM LAKES IN THE NORTHEAST REGION OF ALBERTA. (continued)

Ironwood Lake			
i	Walleye N = 7	log Hg = -6.3814 + 5.5229 log L	(r = 0.97)
ii	Northern pike N = 10	log Hg = -5.8087 + 4.9397 log L	(r = 0.89)
Kinnaird Lake			
i	Northern pike N = 10	log Hg = -12,3610 + 8.7586 log L	(r = 0.75)
ii	Walleye N = 10	log Hg = -6.3509 + 5.3642 log L	(r = 0.91)
Lac La Nonne			
i	Northern pike N = 10	log Hg = -4.6858 + 4.1001 log L	(r = 0.79)
ii	Walleye N = 10	log Hg = -5.2348 + 4.7523 log L	(r = 0.97)
Lac Ste. Anne			
	Northern pike N = 10	log Hg = -1.1925 + 2.011 log L	(r = 0.53)
Lake Athabasca			
	Northern pike N = 10	log Hg = -4.9624 + 4.2928 log L	(r = 0.98)
Moose Lake			
i	Northern pike N = 11	log Hg = -4.7941 + 4.2137 log L	(r = 0.88)
ii	Walleye N = 10	log Hg = -5.9287 + 5.1724 log L	(r = 0.97)
Muriel Lake			
i	Northern pike N = 12	log Hg = -4.5326 + 4.1417 log L	(r = 0.97)
ii	White sucker	poor correlation, r = 0.25	
Muskwa Lake			
	Northern pike N = 10	log Hg = -6.5963 + 5.3108 log L	(r = 0.97)
Pine Lake			
	Northern pike N = 6	log Hg = 15.7745 + 4.7809 log L	(r = 0.99)
Round Lake			
i	Northern pike N = 10	log Hg = -7.6238 + 5.6800 log L	(r = 0.89)
ii	Walleye N = 5	log Hg = -1.8676 + 2.5276 log L	(r = 0.82)
Whitefish Lake			
i	Northern pike N = 10	log Hg = -1.9755 + 2.6725 log L	(r = 0.86)
ii	Walleye N = 9	log Hg = -4.7483 + 4.4639 log L	(r - 0.86)

TABLE 8. MEAN TOTAL MERCURY (µg/fish) AND UPPER 95% CONFIDENCE LIMIT IN FISH FROM LAKES IN THE NORTHEAST REGION OF ALBERTA.

Brintnell Lake - Northern Pike								
Length (cm)					45	50	55	60
Mean Hg					283	292	302	311
U 95% CL Hg/MBW					752	647	608	623

Christina Lake - Northern Pike								
Length (cm)	40	45	50	55	60	65	70	80
Mean Hg	91	121	158	200	249	305	368	515
U 95% CL Hg/MBW	251	366	451	558	695	867	1081	1667

Elinor Lake - Northern Pike								
Length (cm)					35	40	45	50
Mean Hg					254	324	402	488
U 95% CL Hg/MBW					393	487	620	798

Graham Lake - Northern Pike								
Length (cm)	45	50	55	60	65	70	75	80
Mean Hg	103	111	118	124	130	137	143	149
U 95% CL Hg/MBW	280	278	284	296	315	340	369	403

Graham Lake - Walleye									
Length (cm)	10	15	20	25	30	35	40	45	50
Mean Hg	106	119	130	138	146	153	159	164	170
U 95% CL MBW	363	378	398	422	448	473	500	525	553

Helena Lake - Northern Pike							
Length (cm)				50	55	60	65	70
Mean Hg				253	290	327	366	406
U 95% CL MBW				431	435	466	534	639

Helena Lake - Walleye							
Length (cm)			45	50	55	60	65	70
Mean Hg			502	465	434	407	384	364
U 95% CL/MBW			816	726	695	698	720	751

Hilda Lake - Northern Pike									
Length (cm)	35	40	45	50	55	60	65	70	75
Mean Hg	151	198	250	310	377	450	528	614	707
U 95% CL/MBW	257	319	395	485	591	716	859	1095	1213

Ironwood Lake - Walleye					
Length (cm)			35	40	45	50
Mean Hg			274	399	553	743
U 95% CL/MBW			574	759	1059	1551

TABLE 8. MEAN TOTAL MERCURY (µg/fish) AND UPPER 95% CONFIDENCE LIMIT IN FISH FROM LAKES IN THE NORTHEAST REGION OF ALBERTA (Continued).

Ironwood Lake - Northern Pike				
Length (cm)	45	50	55	60
Mean Hg	311	398	498	610
U 95% CL Hg/MBW	460	561	752	1045

Kinnaird Lake - Northern Pike			
Length (cm)	45	50	55
Mean Hg	112	269	594
U 95% CL Hg/MBW	290	433	1111

Kinnaird Lake - Walleye					
Length (cm)	35	40	45	50	55
Mean Hg	170	227	294	369	454
U 95% CL/MBW	333	401	519	700	961

Lac La Nonne - Northern Pike					
Length (cm)	40	45	50	55	60
Mean Hg	164	183	202	221	240
U 95% CL Hg/MBW	484	488	531	611	728

Lac La Nonne - Walleye								
Length (cm)	35	40	45	50	55	60	65	70
Mean Hg	227	294	371	456	549	652	762	881
U 95% CL/MBW	409	505	624	770	946	1158	1406	1694

Lac Ste. Anne - Northern Pike					
Length (cm)	40	45	50	55	60
Mean Hg	188	162	142	126	113
U 95% CL/MBW	1177	727	526	447	435

Lake Athabasca - Northern Pike								
Length (cm)	45	50	55	60	65	70	75	80
Mean Hg	206	230	254	274	302	325	350	374
U 95% CL/MBW	306	330	359	390	425	463	505	550

Moose Lake - Northern Pike										
Length (cm)	30	35	40	45	50	55	60	65	70	75	80
Mean Hg-	108	135	165	197	230	265	301	340	379	421	462
U95%CL/MBW	540	577	633	707	804	926	1074	1252	1462	1709	1989

Moose Lake - Walleye							
Length (cm)	30	35	40	45	50	55	60
Mean Hg	157	222	300	392	497	616	750
U 95% CL Hg/MBW	341	459	608	794	1023	1303	1639

TABLE 8. MEAN TOTAL MERCURY (µg/fish) AND UPPER 95% CONFIDENCE LIMIT IN FISH FROM LAKES IN THE NORTHEAST REGION OF ALBERTA (Continued).

Muriel Lake - Northern Pike											
Length (cm)	35	40	45	50	55	60	65	70	75	80	85
Mean Hg	191	221	251	282	313	344	375	407	439	471	503
U 95%CL Hg /MBW	458	509	564	623	687	755	829	906	989	1076	1169

Muskwa Lake - Northern Pike										
Length (cm)	45	50	55	60	65	70	75	80	85	90
Mean Hg	195	247	304	370	441	519	605	699	799	907
U95% CL Hg/MBW	451	549	660	794	947	1125	1332	1568	1836	2141

Pine Lake - Northern Pike									
Length (cm)	45	50	55	60	65	70	75	80	85
Mean Hg	175	208	243	280	319	359	402	447	493
U 95% CL Hg/MBW	340	394	454	527	607	698	802	917	1045

Round Lake - Northern Pike							
Length (cm)	45	50	55	60	65	70	75
Mean Hg	68	91	118	150	187	230	278
U 95% CL Hg/MBW	249	290	344	417	514	643	811

Whitefish Lake - Northern Pike							
Length (cm)	40	45	50	55	60	65	70
Mean Hg	253	269	285	301	316	330	344
U 95% CL Hg/MBW	559	547	549	562	586	620	662

Whitefish Lake - Walleye					
Length (cm)	35	40	45	50	
Mean Hg	248	317	395	480	
U 95% CL Hg/MBW	513	617	818	1135	

3.5 North Saskatchewan River

There were four collection sites on the North Saskatchewan River. Brown trout and Rocky Mountain whitefish were collected at the uppermost site (Rocky Mountain House) (Appendix XX). Average methyl mercury and total mercury levels in brown trout were 59 and 87 µg/kg, whereas corresponding values for Rocky Mountain whitefish

	Drayton Valley	Genesee	Devon
Walleye			
methyl -Hg (µg/kg)	349	706	568
total -Hg (µg/kg)	368(N=8)	754(N=1)	597(N=4)
Sauger			
methyl -Hg (µg/kg)	275	No data	657
total -Hg (µg/kg)	378(N=4)	No data(N=0)	690(N=2)
Goldeye			
methyl -Hg (µg/kg)	420	446	340
total -Hg (µg/kg)	452(N=10)	491(N=9)	374(N=10)
Northern Pike			
methyl -Hg (µg/kg)	132	128	No data
total -Hg (µg/kg)	156(N=6)	159(N=1)	No data(N=0)

were 112 and 146 µg/kg. Although one walleye and one sauger were collected from the Rocky Mountain House site, both species as well as goldeye and northern pike were taken with greater frequency at the three downstream sites. At the Devon site, methyl and total -Hg residues were well over 500 µg/kg in sauger and walleye. Methyl-Hg and total-Hg levels in goldeye averaged 340 and 374 µg/kg respectively, whereas at the other two sites, they ranged from 420 to 491 µg/kg.

The log-log regression equations relating mercury residues to fish length are listed in Table 9. At some sites, the sample size was too small to yield a satisfactory correlation for a particular species and thus no regression is given. The goldeye, sauger and walleye from the Drayton Valley area contained appreciable amounts of mercury at the upper 95% confidence limit (Table 10) whereas

residues in northern pike were always below 500 µg/kg. Goldeye from the Devon Site contained high concentrations, with the mean and upper 95% confidence limit averaging 747 and 2252 µg/kg, respectively, for a 40 cm fish.

TABLE 9. RELATIONSHIP BETWEEN TOTAL MERCURY LEVELS (µg/fish) AND FISH LENGTH (cm) IN THE NORTH SASKATCHEWAN RIVER (4 LOCATIONS).

Rocky Mountain House		
i	Brown Trout N = 10	log Hg = -5.0002 + 4.4831 log L (r = 0.98)
ii	Whitefish N = 10	poor correlation, r = 0.12
Drayton Valley		
i	Walleye N = 8	log Hg = -3.6158 + 3.7622 log L (r = 0.84)
ii	Sauger N = 4	log Hg = -11.6272 + 9.1205 log L (r = 0.89)
iii	Goldeye N = 9	log Hg = -3.6976 + 3.9366 log L (r = 0.73)
iv	Northern Pike N = 6	log Hg = -0.6217 + 1.5267 log L (r = 0.55)
Genesee		
	Goldeye N = 9	poor correlation, r = -0.37
Devon		
	Goldeye N = 10	log Hg = -10.4894 + 8.3334 log L (r = 0.85)

TABLE 10. MEAN TOTAL MERCURY (µg/fish) AND UPPER 95% CONFIDENCE LIMIT IN FISH COLLECTED FROM DIFFERENT SITES ON THE NORTH SASKATCHEWAN RIVER.

Rocky Mountain House - Brown Trout					
Length (cm)	15	20	25	30	35
Mean Hg	43	68	94	123	158
U 95% CL Hg/MBW	87	127	176	238	320
N = 10					
Drayton Valley - Walleye					
Length (cm)	35	40	45	50	55
Mean Hg	306	339	366	393	419
U 95% CL Hg/MBW	853	860	936	1085	1300
N = 8					
Drayton Valley - Sauger					
Length (cm)				30	35
Mean Hg				228	544
U 95% CL Hg/MBW				1294	4173
N = 4					

TABLE 10. MEAN TOTAL MERCURY LEVEL (µg/kg) AND UPPER 95% CONFIDENCE LIMIT IN FISH COLLECTED FROM DIFFERENT SITES ON THE NORTH SASKATCHEWAN RIVER.

Drayton Valley - Goldeye			
Length (cm)	30	35	40
Mean Hg	336	453	592
U 95% CL Hg/MBW	702	807	1259
N = 10			
Drayton Valley - Northern Pike			
Length (cm)	35	40	45
Mean Hg	180	134	103
U 95% CL Hg/MBW	331	269	266
N = 6			
Devon - Goldeye			
Length (cm)	30	35	40
Mean Hg	180	386	747
U 95% CL Hg/MBW	512	939	2252
N = 9			

3.6 Smoky River

Three species of fish (longnose sucker, white sucker, northern pike) were collected from the Smoky River (Appendix XXIII). Longnose sucker was the most common species; methyl and total -Hg levels were 201 and 230 µg/kg. Only one northern pike and one white sucker were collected. Residues in both species were < 230 µg/kg.

The log-log regression equation relating mercury content to length in longnose sucker is:

$$\log Hg = -5.2062 + 4.6822 \log L \quad (r = 0.89)$$

$$N = 16$$

Based on this regression, average mercury levels in fish of 20 and 50 cm were 73 and 364 µg/kg respectively; the upper 95% confidence limits were 262 and 1111 µg/kg for fish of the same length. Regression data for fish of other lengths are listed below:

Longnose Sucker

Length (cm)	20	25	30	35	40	45	50
Mean Hg	73	109	148	196	246	303	364
U 95% CL/MBW	262	335	423	541	690	880	1111

N = 16

3.7 Wapiti River

Four species were collected (Appendix XXIV). The most abundant species was longnose sucker, followed by Rocky Mountain whitefish. Only one northern pike and one white sucker were collected. Methyl and total -Hg residues in longnose sucker were 238 and 272 µg/kg, whereas the corresponding values for Rocky Mountain Whitefish were 58 and 102 µg/kg respectively. Total residues in the one northern pike exceeded 600 µg/kg and that of the white sucker was 289 µg/kg.

The log-log regression relating mercury content to fish length was calculated only for longnose sucker, the only species in which the sample size was relatively large. The equation is:

$$\log Hg = -7.5528 + 6.1985 \log L \quad (r = 0.80)$$

N = 17

Based on this equation, average mercury residues in fish of 30 and 45 cm were 126 and 454 µg/kg respectively, with upper 95% confidence limits of 420 and 1523 µg/kg, as outlined below:

Longnose Sucker

Length (cm)	30	35	40	45
Mean Hg	126	205	313	454
U 95% CL/MBW	420	611	947	1523
N = 17				

4. DISCUSSION

The federal guidelines for mercury in commercially marketed fish is 0.5 mg/kg (500 µg/kg) in Canada. This level is often taken as the maximum standard for unlimited consumption of fish (MOE, 1984-1985). Beyond 500 µg/kg, consumption may be restricted in sensitive groups. Pregnant women are generally considered sensitive because mercury is rapidly transported across the placenta and is accumulated in the developing fetus (Khera, 1979).

Absorption of methyl mercury from the gastrointestinal tract is over 90% in both experimental animals and humans (Jugo, 1979). There is little evidence to indicate that young animals absorb more or less methyl mercury from the gut than adults. However, because the half-life of methyl mercury in tissues is extremely long, young animals are likely to accumulate more mercury than adults over their lifetimes, assuming that exposure was initiated at the same point in time. This simply reflects the fact that young animals

will live longer than adults. Therefore, children may also be identified as a sensitive group.

The correlations observed between mercury residues and fish length in this study have been reported in many other investigations (Nriagu, 1979). As a general trend, therefore, limitations on consumption increase with fish size. In Alberta, these limitations generally fall within the 1-10 meal per week range for non-sensitive groups.

Most of the lakes under investigation have no potential source of anthropogenic mercury. The shoreline is either wooded or surrounded by agricultural land with no municipal or industrial development. There is also no evidence that mercury-based fungicides have significantly contaminated lakes or rivers in Alberta. This leads to the conclusion that the residues found in fish originate from natural environmental sources. Residues of over 2.0 mg/kg have been reported for fish inhabiting remote lakes in the Precambrian Shield (Moore and Ramamoorthy, 1984).

Current research at the Alberta Environmental Centre is concentrating on the analysis of residues in fish from an additional series of lakes in Alberta.

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APPENDIX I.

QUALITY ASSURANCE DATA

Government of Canada / Gouvernement du Canada

Fisheries and Oceans / Pêches et Océans

(40)

June 1, 1984.

TO: Mercury Quality Assurance Program Participants

Following are the results for those samples sent to you for total mercury determination on June 27, 1983.

Laboratory Number	Sample Number 140	141	142	143	Method	Instrumentation
1	0.29±0.01	0.20±0.01	0.86±0.02	0.33±0.01	HNO_3, H_2SO_4	Perkin Elmer 403
2	0.39±0.03	0.23±0.03*	1.08±0.06*	0.43±0.03	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 306
3	0.30±0.03	0.21±0.02	0.91±0.03	0.38±0.03	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
4	0.28±0.00	0.17±0.01	0.86±0.03	0.32±0.02	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
5	0.34±0.03	0.19±0.01	0.81±0.07	0.38±0.02	HNO_3, H_2SO_4	Pharmacia UV 100
7	0.32±0.02	0.19±0.01	0.88±0.02	0.41±0.01	HNO_3, H_2SO_4	LDC Mercury Monitor
10	0.25±0.01	0.17±0.01	0.77±0.01	0.40±0.01	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 403
11	0.33±0.01	0.19±0.01	0.96±0.02	0.37±0.01	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
16	0.28±0.02	0.16±0.02	0.88±0.07	0.37±0.04	HNO_3, H_2SO_4	Perkin Elmer 403
17	0.33±0.01	0.18±0.01	0.90±0.04	0.38±0.01	HNO_3, H_2SO_4,	Perkin Elmer 306
19	0.31±0.00	0.18±0.01	0.41±0.01*	0.37±0.01	H_2SO_4, H_2O_2	Pharmacia Mercury Monitor
20	0.26±0.01	0.15±0.01	0.75±0.01	0.31±0.01	HNO_3, H_2SO_4, V_2O_5	Perkin Elmer 373
21	0.26±0.03	0.17±0.01	0.71±0.02	0.33±0.03	HNO_3, H_2SO_4, $KMnO_4$	Coleman MAS-50
27	0.32±0.05	0.20±0.03	0.94±0.16	0.44±0.06	HNO_3, H_2SO_4	Perkin Elmer 403
30	0.32±0.03	0.17±0.02	0.76±0.01	0.37±0.02	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
31	0.37±0.04	0.17±0.04	0.88±0.07	0.41±0.06	NaOH ,$CdCl_2$,$SnCl_2$,H_2SO_4	LDC Mercury Monitor
34	0.29±0.02	0.21±0.02	0.93±0.04	0.40±0.03	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
37	0.34±0.01	0.19±0.01	0.94±0.03	0.35±0.02	HNO_3, H_2SO_4	Pharmacia Mercury Monitor
39	0.30±0.03	0.17±0.02	0.59±0.03*	0.29±0.02	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
40	0.13±0.03*	0.07±0.01*	0.39±0.09*	0.16±0.03*	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
Mean Standard Deviation	0.30±0.06(20)	0.18±0.03(20)	0.81±0.18(20)	0.36±0.06(20)		
Corrected Mean Std. Dev.	0.31±0.04(19)	0.18±0.02(18)	0.86±0.08(16)	0.37±0.04(19)		

where the number in brackets is the number of results used in the calculation.

All results are in ppm. Your laboratory number is 39.

Corrected means and standard deviations were calculated as a result of rejecting those values (asterisked) greater than 2 standard deviations from the mean, and repeating the process until all values were less than 2 standard deviations from the mean.

Any comments you may have regarding this study are welcomed. The next set of samples will be distributed during middle of June. Thank you for your participation.

Sincerely,

M. Hendzel
Regional Chemist
Western Region
Department of Fisheries & Oceans
Winnipeg, Manitoba.

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Alberta Environmental Centre

Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
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JUN 5 1984

Institut des eaux douces
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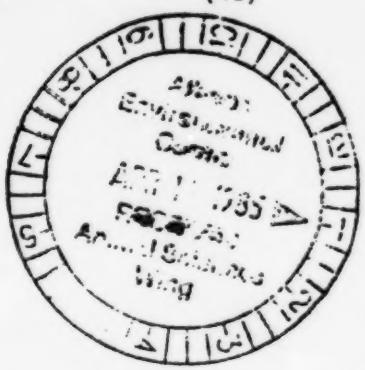

Your file Votre référence

Our file Notre référence
File: 020-4
TS34:MQAPALTA.020

April 1, 1985

Dr. S. Ramamoorthy
Head, Limnology Section
Animal Science Wing
Alberta Environment Centre
Bag 4000
VEGREVILLE, Alberta.
T0B 4L0

Dear Dr. Ramamoorthy,

Thank you for your mercury results on the four blind Quality Assurance Fish Standards mailed to you in February. The four samples in question were previously analyzed by a number of other laboratories as part of our ongoing Mercury Quality Assurance Program. Mean results obtained by other participating laboratories and those submitted by your laboratory are presented as follows:

	Others	Your Laboratory
A	0.34±0.04 (20)	0.37±0.04
B	0.49±0.06 (20)	0.50±0.04
C	0.62±0.04 (17)	0.64±0.09
D	1.19±0.13 (19)	1.20±0.08

where the number in brackets is the number of participating laboratories.

The small sample size (four) does not permit a comparison of the data using an accepted statistical test, ie. Student's t. However, in every case your results lie within the accepted range and are indicative of a level of performance that is fully satisfactory.

Sincerely,

M. Hendzel
Regional Chemist
Southern Operations Directorate

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(42)

TO: Mercury Quality Assurance Program Participants

May 27, 1985.

Your file / Votre référence

Following are the results for those samples sent to you for total mercury determination on March 1, 1985:

Laboratory Number	Sample Number 152	153	154	155	Method	Our file / Notre référence
1	0.93±0.03	0.39±0.02	0.22±0.01	0.58±0.02	HNO_3, H_2SO_4	Perkin Elmer 403
2	1.01±0.04	0.45±0.02	0.25±0.01	0.67±0.03	HNO_3, H_2SO_4	LDC Mercury Monitor
3	0.97±0.01	0.45±0.03	0.28±0.01	0.64±0.04	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
4	0.92±0.03	0.40±0.02	0.25±0.01	0.60±0.01	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
5	0.92±0.05	0.45±0.04	0.24±0.01	0.61±0.04	HNO_3, H_2SO_4	Pharmacia UV 100
7	1.00±0.02	0.43±0.01	0.25±0.01	0.63±0.02	HNO_3, H_2SO_4	LDC Mercury Monitor
10	1.00±0.01	0.45±0.01	0.26±0.01	0.67±0.01	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 403
11	0.86±0.02*	0.34±0.03	0.20±0.01	0.50±0.01*	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
16	0.97±0.07	0.39±0.02	0.23±0.01	0.59±0.01	HNO_3, H_2SO_4	IL 351
17	1.06±0.07	0.46±0.04	0.27±0.02	0.67±0.05	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
19	1.04±0.02	0.48±0.05	0.30±0.02	0.78±0.04*	HNO_3, H_2O_2	LDC Mercury Monitor
27	0.95±0.08	0.42±0.04	0.24±0.04	0.63±0 04	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 403
30	0.75±0.02*	0.35±0.06	0.21±0.01	0.49±0.03*	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
31	0.95±0.03	0.43±0.02	0.22±0.02	0.62±0.04	NaOH, $OSCl_2$, $SnCl_2$, H_2SO_4	LDC Mercury Monitor
33	0.99±0.10	0.63±0.06*	0.51±0.03*	0.71±0.05	HNO_3, H_2SO_4, $KMnO_4$	Varian AA 5
37	1.05±0.03	0.47±0.01	0.28±0.01	0.66±0.02	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
39-I	0.95±0.03	0.42±0.05	0.23±0.02	0.62±0.04	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
39-II	0.97±0.09	0.43±0.05	0.24±0.02	0.63±0.05	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
40	0.81±0.09*	0.38±0.02	0.24±0.03	0.73±0.08	HNO_3, H_2SO_4, $KMnO_4$	Fisher Hg Analyzer
41	0.81±0.01*	0.39±0.02	0.18±0.01	0.55±0.03	HNO_3, $HClO_4$	Pharmacia UV 100
Mean and Standard Deviation	0.95±0.08(20)	0.43±0.06(20)	0.26±0.07(20)	0.63±0.07(20)		
Corrected Mean and Stand.Dev.	0.98±0.04(16)	0.42±0.04(19)	0.24±0.03(19)	0.64±0.05(17)		

where the number in brackets is the number of results used in the calculation.

All results are in ppm. Your laboratory number is 39.

Corrected means and standard deviations were calculated as a result of rejecting those values (asterisked) greater than 2 standard deviations from the mean, and repeating the process until all values were less than 2 standard deviations from the mean. Any comments you may have regarding this study are welcomed.

The next set of samples will be distributed in June. Thank you for your participation.

Sincerely,

M. Hendzel
Regional Chemist

Freshwater Institute
501 University Crescent
Winnipeg, Manitoba
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Alberta Environmental Centre

Institut des eaux douces
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TO: **Mercury Quality Assurance Program Participants**

August 30, 1985

Following are the results for those samples sent to you for total mercury determination on June 12, 1985:

Lab #	Sample Number 156	157	158	159	Method	Instrumentation
1	0.17±0.01	0.51±0.02	0.38±0.02	1.44±0.04	HNO_3, H_2SO_4	Perkin Elmer 403
2	0.21±0.01	0.68±0.03*	0.47±0.03	1.64±0.10	HNO_3, H_2SO_4	LDC Mercury Monitor
3	0.20±0.01	0.58±0.03	0.42±0.01	1.47±0.05	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
4	0.19±0.01	0.51±0.02	0.40±0.02	1.16±0.03	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
5	0.21±0.01	0.57±0.03	0.42±0.02	1.54±0.14	HNO_3, H_2SO_4	Pharmacia UV 100
7	0.19±0.01	0.57±0.01	0.41±0.01	1.46±0.06	HNO_3, H_2SO_4	LDC Mercury Monitor
0	0.19±0.01	0.58±0.00	0.41±0.01	1.37±0.05	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 403
1	0.19±0.01	0.51±0.01	0.39±0.01	1.27±0.05	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
6	0.19±0.01	0.54±0.02	0.39±0.02	1.48±0.04	HNO_3, H_2SO_4	LDC Mercury Monitor
7	0.19±0.02	0.56±0.02	0.44±0.02	1.51±0.07	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
9	0.20±0.01	0.62±0.02	0.43±0.03	1.61±0.07	HNO_3, H_2SO_4	LDC Mercury Monitor
7	0.20±0.02	0.60±0.01	0.43±0.02	1.66±0.12	HNO_3, H_2SO_4, $KMnO_4$	Perkin Elmer 403
0	0.20±0.01	0.56±0.03	0.41±0.03	1.27±0.08	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
	0.17±0.01	0.51±0.03	0.38±0.02	1.49±0.08	NaOH, $CdCl_2$, $SnCl_2$, H_2SO_4	LDC Mercury Monitor
7	0.20±0.01	0.60±0.02	0.42±0.01	1.59±0.03	HNO_3, H_2SO_4	LDC Mercury Monitor
9	0.22±0.01	0.54±0.04	0.41±0.02	1.51±0.10	HNO_3, H_2SO_4, $KMnO_4$	LDC Mercury Monitor
9	0.16±0.02	0.58±0.06	0.35±0.03	1.25±0.04	HNO_3, H_2SO_4, $KMnO_4$	Fisher Hg Analyzer
an and andard viation	0.19±0.02(17)	0.57±0.05(17)	0.41±0.03(17)	1.45±0.15(17)		
rrected an and and.Dev.	0.19±0.02 (0)	0.56±0.04(16)	0.41±0.03 (0)	1.45±0.15 (0)		

ere the number in brackets is the number of results used in the calculation.

l results are in ppm. Your laboratory number is ..39...

rrected means and standard deviations were calculated as a result of rejecting those values sterisked) greater than 2 standard deviations from the mean, and repeating the process until l values were less than 2 standard deviations from the mean. Any comments you may have garding this study are welcomed.

e next set of samples will be distributed in September. Thank you for your participation.

Sincerely,

Monique Hendzel

M. Hendzel
Regional Chemist, Western Region
Department of Fisheries & Oceans
Winnipeg, Manitoba.

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APPENDIX II. MERCURY (µg/kg, ppb) IN FISH FROM THE ATHABASCA RIVER

SPECIES: Northern Pike
LOCATION: Athabasca River - Athabasca Bridge

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	34.9	322	32	110	142	77.2
SPECIES:	Goldeye						
1	Male	32.0	290	54	180	234	76.9
2	Male	32.9	419	41	203	244	83.2
3	Female	34.2	509	67	202	269	75.0
4	Male	32.5	448	32	183	215	85.1
5	Female	34.5	540	34	227	261	87.1
6	Male	32.5	390	35	176	211	83.5
7	Male	32.9	467	35	288	323	89.3
SPECIES:	White Sucker						
1	Male	29.6	428	43	80	123	64.9
2	Male	29.0	376	34	82	116	70.4
SPECIES:	Flathead Chub						
1	Female	25.4	204	35	143	178	80.4
2	Female	22.1	130	84	57	141	40.7
3	Female	21.4	145	53	123	176	70.0

SPECIES: Longnose Sucker
LOCATION: Athabasca River - Athabasca Bridge

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	32.9	523	50	153	203	75.4
2	Male	32.2	520	34	175	209	83.6
3	Female	36.3	572	30	370	400	92.3

SPECIES: Northern Pike
LOCATION: Athabasca River - Calling River

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	51.6	982	25	209	234	89.1
2	Male	37.0	305	64	124	188	66.2
3	Female	39.0	387	63	144	207	69.6
SPECIES:	Longnose Sucker						
1	Female	34.1	418	26	281	307	91.7
SPECIES:	Walleye						
1	Immature	32.9	417	21	247	268	92.1
SPECIES:	Arctic Grayling						
1	Male	33.7	479	40	103	143	72.3

SPECIES: Rocky Mountain Whitefish
LOCATION: Athabasca River - Hondo Bridge

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	34.0	549	29	53	82	64.8
2	Female	36.2	662	43	35	78	44.9
SPECIES:	Walleye						
1	Male	33.4	430	34	175	209	83.8
2	Male	32.8	393	28	305	333	91.4
SPECIES:	Goldeye						
1	Male	30.9	354	34	236	270	87.5
2	Female	29.7	318	31	105	136	76.8
3	Male	31.4	346	30	152	182	83.5
4	Female	33.9	490	53	227	280	81.2
5	Male	31.7	404	48	172	220	78.1

SPECIES: Walleye
LOCATION: Athabasca River - Downstream of Suncor

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	39.4	683	46	105	151	69.6
2	Male	44.3	987	41	558	599	93.1
3	Male	50.4	1441	43	421	464	90.7
4	Male	41.8	831	62	88	150	59.0
5	Male	33.5	387	49	293	342	85.6
6	Male	38.4	572	36	428	464	92.3
7	Male	40.9	758	38	234	272	86.0
8	Male	44.9	1181	41	239	280	85.3
9	Male	42.0	852	53	687	740	92.9
10	Male	42.8	902	40	510	550	92.6
11	Male	39.0	679	47	432	479	90.3
12	Female	43.2	1055	37	266	301	88.5
13	Female	55.7	2307	40	303	343	88.4
14	Male	38.8	632	43	367	410	89.4
15	Male	35.9	554	51	158	209	75.5
16	Male	41.4	812	71	484	555	87.3
17	Male	51.5	1480	32	476	508	93.7
18	Male	32.8	393	56	105	161	65.7
19	Male	45.4	1003	50	399	449	88.7
20	Female	48.2	1293	33	259	292	88.7

SPECIES: Goldeye
LOCATION: Athabasca River - Downstream of Suncor

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	38.6	733	23	228	251	90.7
2	Female	32.6	425	36	189	225	84.2
3	Female	41.4	1179	32	111	143	77.6
4	Male	34.0	444	41	211	252	83.8
5	Female	34.3	501	57	172	229	75.0
6	Male	28.9	303	41	84	125	67.5
7	Male	41.5	936	41	63	104	61.0
8	Male	31.3	383	23	210	233	90.3
9	Male	38.8	898	44	58	102	57.2
10	Female	29.5	308	35	91	126	72.6

SPECIES: Lake Whitefish
LOCATION: Athabasca River - Downstream of Suncor

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	37.4	704	28	54	82	66.0
2	Female	35.4	680	33	25	58	44.2
3	Female	41.3	928	40	51	91	55.8
4	Male	36.5	730	25	45	70	64.8
5	Female	42.6	1137	27	53	80	66.1
6	Female	44.6	1333	24	147	171	86.0
7	Female	37.0	757	24	37	61	61.3
8	Male	35.2	693	36	19	55	35.6
9	Male	37.6	995	45	4	49	8.0
10	Male	40.6	925	38	49	87	56.7
SPECIES: Longnose Sucker							
1	Female	35.2	659	49	47	96	49.1
2	Female	36.9	713	41	91	132	69.2
3	Female	34.8	528	43	115	158	72.6
4	Male	36.4	663	43	154	197	78.2
5	Female	42.6	1161	64	21	85	25.5
6	Male	38.6	778	50	110	160	68.9
7	Male	41.2	1011	71	10	81.0	13.1

SPECIES: Northern Pike
LOCATION: Athabasca River - Downstream of Suncor

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	49.6	810	44	214	258	83.0
2	Female	44.5	644	24	124	148	83.9
3	Female	62.5	1872	26	438	464	94.4

SPECIES: Longnose Sucker
LOCATION: Athabasca River - Klondyke Ferry

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	32.2	406.0	50	59	109	54.7
2	Male	34.3	539.0	38	138	176	78.1
SPECIES: Flathead Chub							
1	Female	22.4	142.0	23	79	102	77.0
SPECIES: Walleye							
1	Male	27.0	204.6	36	160	196	81.3
Species: Rocky Mountain Whitefish							
1	Female	46.5	1206.0	50	45	95	47.5

APPENDIX III. MERCURY (µg/kg, ppb) IN FISH FROM BLACKETT LAKE.

SPECIES: Northern Pike*

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	41.5	-	86	90	176	51
2	-	-	-	49	342	391	87
3	Female	43.2	-	46	138	184	75
4	Female	39.2	-	81	137	218	63

- not available, *heads only

Quality Assurance

Mercury Quality Assurance Program Sample Number 2D	Our Results
1190 ± 130 µg/kg	1230 ± 80 µg/kg

APPENDIX IV. MERCURY (µg/kg, ppb) IN FISH FROM BRINTNELL LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	53.9	1136	61	362	423	85.7
2	Male	62.8	2092	51	423	474	89.2
3	Male	55.0	1324	67	160	227	70.6
4	Male	48.7	1245	65	246	311	79.1
5	Male	57.8	1413	56	195	251	77.6
6	Male	62.5	1683	31	277	308	89.9
7	Male	60.6	1568	51	216	267	81.0
8	Male	57.2	1429	38	254	292	86.8
9	Male	58.6	1480	30	269	299	90.1
10	Male	60.1	1652	24	263	287	91.7

Quality Assurance

Mercury Quality Assurance Program Sample Number 2A	Our Results
370 ± 40 µg/kg	410 ± 20 µg/kg

APPENDIX V. MERCURY (µg/kg, ppb) IN FISH FROM CHRISTINA LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	83.9	5781	72	600	672	89
2	Male	43.9	601	39	64	103	63
3	Female	62.7	2090	37	114	151	76
4	Female	51.1	977	22	110	132	83
5	Male	59.8	1730	22	213	235	90
6	Female	63.2	2409	50	256	306	84
7	Male	58.5	1765	62	310	372	83
8	Female	45.8	730	93	78	171	46

Quality Assurance

Mercury Quality Assurance Program Sample Number 150	Our Results
790 ± 50 µg/kg	790 ± 30 µg/kg

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: Rocky Mountain Whitefish

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Unknown	16.4	53	64	105	169	62
2	Female	18.6	64	27	74	101	73
3	Female	22.9	139	22	120	142	85
4	Female	23.2	134	35	161	196	82
5	Male	19.2	68	23	248	271	92
6	Female	23.0	130	37	247	284	87
7	Male	27.4	200	19	73	92	79
8	Male	23.8	132	39	37	76	49
9	Male	21.8	114	29	100	129	78
10	Male	29.2	251	40	246	286	86
11	Male	23.7	137	40	38	78	49
12	Male	19.7	79	31	114	145	79
13	Male	19.9	88	41	54	95	57
14	Female	21.0	107	55	179	234	76
15	Male	21.5	98	23	122	145	84
16	Female	31.6	388	29	104	133	78
17	Male	23.8	144	19	64	83	77
18	Unknown	20.3	88	28	157	185	85
19	Female	22.2	123	37	241	278	87
20	Male	23.1	132	27	174	201	87

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: Burbot

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	47.7	585	37	202	239	85
2	Male	48.9	617	37	248	285	87
3	Female	23.5	67	21	155	176	88
4	Female	52.1	1077	33	249	282	88
5	Female	46.8	563	39	318	357	89
6	Female	28.1	129	33	218	251	87
7	Male	47.0	721	37	213	250	85
8	Female	54.9	927	37	339	376	90
9	Male	57.0	1135	33	284	317	90
10	Male	56.5	1099	66	173	239	73
11	Male	50.6	965	39	146	185	79
SPECIES: Rainbow Trout							
1	Male	27.7	276	21	160	181	89
SPECIES: Brown Trout							
1	Male	42.2	862	38	5	43	12

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: Longnose Sucker

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	38.9	718	24	209	233	90
2	Female	29.3	347	59	160	219	73
3	Male	35.5	635	14	170	184	92
4	Female	32.0	456	37	94	131	72
5	Female	28.6	326	54	101	155	65
6	Female	33.3	509	20	193	213	91
7	Female	31.3	443	12	146	158	92
8	Female	35.5	632	26	128	154	83
9	Female	31.5	405	18	91	109	83
10	Female	37.0	691	23	182	205	89
11	Female	36.5	679	41	141	182	77
12	Female	38.4	795	45	162	207	78
13	Male	34.5	571	23	184	207	89
14	Female	38.0	701	34	158	192	82
15	Female	33.8	495	33	195	228	86
16	Female	37.8	784	72	285	357	80
17	Female	37.4	816	29	151	180	84
18	Unknown	21.1	126	25	65	90	72
19	Male	33.9	496	31	139	170	82
20	Male	35.9	718	30	143	173	83

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	46.5	1449	16	348	364	96
2	Male	49.1	1022	33	224	257	87
3	Male	45.1	701	37	291	328	89
4	Male	45.9	767	35	268	303	89
5	Male	46.3	938	66	185	251	74
6	Male	49.7	1109	21	183	204	90
7	Male	50.8	1201	82	143	225	63
8	Female	51.6	1181	40	214	254	84
9	Male	51.6	1154	25	164	189	87
10	Male	48.4	875	25	187	212	88
11	Female	43.5	643	17	230	247	93
12	Female	53.8	1445	32	271	303	89
13	Female	51.8	1115	23	211	234	90
14	Male	52.2	1244	31	211	242	87
15	Female	52.2	1413	48	279	327	85
16	Female	49.9	1068	48	194	242	80
17	Female	51.9	1058	44	405	449	90
18	Female	54.8	1670	33	281	314	89
19	Female	55.0	1331	36	239	275	87
20	Female	47.8	919	32	316	348	91

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: White Sucker

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	34.8	525	45	122	167	73
2	Male	37.7	841	35	126	161	78
3	Male	26.7	244	41	146	187	78
4	Unknown	26.9	288	32	69	101	68
5	Female	35.4	677	26	107	133	80
6	Male	29.1	355	34	80	114	70
7	Male	33.5	530	36	128	164	78
8	Female	31.7	428	46	108	154	70
9	Female	28.8	310	28	157	185	85
10	Female	36.2	703	92	71	163	44
11	Female	31.8	497	50	64	114	56
12	Female	28.8	350	40	84	124	68
13	Female	26.2	267	60	37	97	38
14	Female	36.5	818	51	87	138	63
15	Female	29.2	322	26	87	113	77
16	Female	39.9	970	33	84	117	72
17	Female	28.0	326	65	26	91	29
18	Female	35.2	666	33	121	154	79
19	Female	38.7	896	25	107	132	81
20	Female	34.0	541	22	99	121	82

APPENDIX VI. MERCURY (µg/kg, ppb) IN FISH FROM DICKSON DAM (GLENNIFER LAKE).

SPECIES: White Sucker

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	34.8	525	45	122	167	73
2	Male	37.7	841	35	126	161	78
3	Male	26.7	244	41	146	187	78
4	Unknown	26.9	288	32	69	101	68
5	Female	35.4	677	26	107	133	80
6	Male	29.1	355	34	80	114	70
7	Male	33.5	530	36	128	164	78
8	Female	31.7	428	46	108	154	70
9	Female	28.8	310	28	157	185	85
10	Female	36.2	703	92	71	163	44
11	Female	31.8	497	50	64	114	56
12	Female	28.8	350	40	84	124	68
13	Female	26.2	267	60	37	97	38
14	Female	36.5	818	51	87	138	63
15	Female	29.2	322	26	87	113	77
16	Female	39.9	970	33	84	117	72
17	Female	28.0	326	65	26	91	29
18	Female	35.2	666	33	121	154	79
19	Female	38.7	896	25	107	132	81
20	Female	34.0	541	22	99	121	82

APPENDIX VII. MERCURY (µg/kg, ppb) IN FISH FROM DRIED MEAT LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	39.1	484	36	86	122	70
2	Male	31.6	256	55	52	107	49
3	Male	45.8	620	29	146	175	83
4	Female	43.2	665	21	163	184	88
5	Male	34.5	397	29	87	116	75
6	Male	42.8	667	37	127	164	78
7	Female	41.9	622	20	185	205	90
8	Female	50.5	926	22	196	218	90
9	Female	60.0	1554	29	157	186	84
10	Female	42.8	634	49	95	144	66
11	Male	48.9	862	21	195	215	90
12	Female	40.5	534	28	179	207	87
13	Female	48.5	856	26	201	227	89
14	Female	57.1	1405	24	211	235	90
15	Female	55.1	1267	34	114	148	77
16	Male	37.7	853	39	116	155	75
17	Female	36.5	381	48	76	124	61
18	Male	41.9	585	17	115	132	87
19	Male	45.5	520	34	175	209	84
20	Female	39.9	510	39	86	125	69
21	Female	41.8	538	41	75	116	64
22	Male	46.0	748	28	185	213	87
23	Male	44.9	684	19	152	171	89
24	Male	41.8	601	21	130	151	86
25	Male	35.8	394	39	96	135	71
26	Female	38.9	456	39	77	116	66
27	Male	46.7	933	27	86	113	75
28	Male	46.3	690	19	160	179	89
29	Female	49.5	878	24	118	142	83
30	Female	42.5	636	27	72	99	73

Quality Assurance

Mercury Quality Assurance Program Sample Numbers		Our Results
#149	320 ± 20 µg/kg	320 ± 0 µg/kg
#150	790 ± 50 µg/kg	700 ± 60 µg/kg

APPENDIX VIII. MERCURY (µg/kg, ppb) IN FISH FROM ELINOR LAKE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	50.9	1552	36	422	458	92
2	Unknown	26.2	202	56	115	171	67
SPECIES::	Northern Pike						
1	Male	39.6	604	121	199	320	62
2	Female	35.8	484	68	164	232	71
3	Female	42.7	797	64	204	268	76
4	Female	49.8	1172	94	353	447	79
5	Male	38.2	475	73	299	372	80
6	Male	40.1	635	84	241	325	74
7	Male	44.3	854	90	436	526	83
8	Female	36.0	398	78	173	251	69
9	Female	38.9	542	54	268	322	83
10	Female	35.8	481	58	212	270	78

Quality Assurance

Mercury Quality Assurance Program Sample Number 2A	Our Results
340 ± 40 µg/kg	440 ± 30 µg/kg

APPENDIX IX. MERCURY (µg/kg, ppb) IN FISH FROM GRAHAM LAKE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	20.0	544	138	48	186	26
2	Male	18.6	571	93	142	235	60
3	Male	17.2	522	45	43	88	49
4	Male	10.2	426	39	24	63	37
5	Female	48.7	1390	52	77	129	60
6	Male	10.3	441	108	22	130	17
7	Male	40.5	840	59	47	106	45
8	Male	42.4	930	74	41	115	36
9	Male	49.8	1480	87	141	228	62
10	Female	40.0	750	114	129	243	53
SPECIES:	Northern Pike						
1	Male	53.1	1150	71	49	120	41
2	Male	49.2	930	39	35	74	49
3	Male	72.2	3060	61	71	132	54
4	Male	61.6	1715	52	26	87	30
5	Male	62.2	1861	82	92	174	53
6	Male	57.3	1506	94	121	215	56
7	Male	79.6	2432	49	133	182	73
8	Male	46.7	724	74	65	139	47
9	Female	66.1	2233	42	54	96	56
10	Female	59.0	1523	32	61	93	65

Quality Assurance

	Mercury Quality Assurance Program Sample Numbers	Our Results
#2A	340 ± 40 µg/kg	390 ± 10 µg/kg
#2D	1190 ± 40 µg/kg	1210 ± 130 µg/kg

APPENDIX X. MERCURY (µg/kg, ppb) IN FISH FROM HELENA LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	57.7	1307	130	240	370	65
2	Female	59.6	2050	107	165	272	61
3	Female	64.8	2551	60	374	434	86
4	Female	61.7	2399	19	287	306	94
5	Female	65.6	2684	47	277	324	86
6	Female	58.5	1999	32	295	327	90
7	Female	64.2	2253	96	347	443	78
8	Female	55.5	1481	46	231	277	84
9	Female	59.2	1885	13	352	365	96
10	Female	62.1	2272	43	224	267	84

Quality Assurance

Mercury Quality Assurance Program Sample Number #2-B	Our Results
500 ± 40 µg/kg	450 ± 50 µg/kg

APPENDIX X. MERCURY (µg/kg, ppb) IN FISH FROM HELENA LAKE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	48.7	1867	131	420	551	76.6
2	Male	50.5	1849	42	507	549	92.4
3	Male	50.5	1503	105	381	486	78.4
4	Male	47.4	1604	99	252	351	71.8
5	Female	59.9	2922	64	345	409	84.4
6	Male	46.3	1638	63	415	478	86.9
7	Male	47.3	1638	51	451	502	89.8
8	Male	49.5	1803	45	507	552	91.8
9	Male	48.7	1605	43	392	435	90.2
10	Male	56.2	2848	47	323	370	87.3

Quality Assurance

Mercury Quality Assurance Program Sample Number #2-D	Our Results
1200 ± 80 µg/kg	1300 ± 40 µg/kg

APPENDIX XI. MERCURY (µg/kg, ppb) IN FISH FROM HILDA LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	52.2	943	80	366	446	82
2	Female	43.3	605	74	120	194	62
3	Male	47.4	819	68	170	238	72
4	Female	42.8	518	32	184	216	85
5	Male	39.7	492	67	127	194	66
6	Male	50.7	984	113	331	444	75
7	Male	48.7	792	114	196	310	63
8	Female	62.4	1793	72	332	404	82
9	Female	52.1	952	160	166	326	51
10	Female	73.8	3223	100	557	657	85

Quality Assurance

Mercury Quality Assurance Program Sample Number #2-A	Our Results
370 ± 40 µg/kg	420 ± 10 µg/kg

APPENDIX XII. MERCURY (µg/kg, ppb) IN FISH FROM IRONWOOD LAKE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	34.8	481	62	234	296	79
2	Male	45.8	1110	63	553	616	90
3	Male	49.4	1186	43	992	1035	96
4	Male	34.7	504	55	254	309	82
5	Female	45.4	1130	39	315	354	89
6	Male	39.9	728	46	311	357	87
7	Unknown	36.3	568	59	221	280	79
SPECIES: Northern Pike							
1	Male	50.7	1036	36	287	323	89
2	Male	50.4	1008	45	440	485	91
3	Female	45.0	780	37	277	314	88
4	Female	52.0	1123	75	317	392	81
5	Male	50.8	1127	28	332	360	92
6	Female	51.4	958	70	356	426	84
7	Male	46.9	794	90	237	327	72
8	Female	51.7	949	48	538	586	92
9	Male	47.6	859	62	252	314	80
10	Male	46.8	736	46	350	396	88

Quality Assurance

Mercury Quality Assurance Program Sample Number #15-D	Our Results
700 ± 60 µg/kg	700 ± 60 µg/kg

APPENDIX XIII. MERCURY (µg/kg, ppb) IN FISH FROM KINNAIRD LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	50.6	978	56	230	286	80.4
2	Female	53.6	989	55	443	498	88.9
3	Male	50.9	997	62	339	401	84.5
4	Female	52.1	1049	36	306	342	89.5
5	Female	50.8	974	52	211	263	80.2
6	Female	50.9	1079	51	315	366	86.0
7	Female	51.9	1030	47	260	307	84.7
8	Female	51.4	846	44	264	308	85.7
9	Female	52.0	1013	23	405	428	94.6
10	Female	49.3	964	40	190	230	82.6

SPECIES: Walleye

1	Unknown	38.3	696	38	151	189	79.8
2	Male	41.0	856	76	212	288	73.6
3	Male	38.6	721	112	112	224	50.0
4	Male	45.0	1158	45	238	283	84.1
5	Male	39.5	698	44	201	245	82.0
6	Unknown	44.4	961	96	87	183	47.5
7	Female	52.0	1886	78	388	466	83.3
8	Female	40.9	871	75	159	234	67.8
9	Female	43.7	982	58	207	265	78.1
10	Female	43.2	940	102	205	307	66.8

Quality Assurance

Mercury Quality Assurance Program Sample Number #2-A	Our Results
340 ± 40 µg/kg	360 ± 10 µg/kg

APPENDIX XIV. MERCURY (µg/kg, ppb) IN FISH FROM LAC LA NONNE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	57.4	1375	41	210	251	83.7
2	Female	51.2	987	44	163	207	78.7
3	Male	44.6	709	37	97	134	72.4
4	Unknown	44.5	603	48	194	242	80.2
5	Female	52.4	1322	33	176	209	84.2
6	Male	40.6	469	48	195	243	80.2
7	Female	44.4	670	19	153	172	88.9
8	Male	45.6	727	81	109	190	57.4
9	Male	49.8	851	48	39	87	44.8
10	Male	57.8	1451	37	316	353	89.5
SPECIES: Walleye							
1	Female	44.8	1095	84	194	278	69.8
2	Male	40.4	856	69	198	267	74.2
3	Female	41.6	866	61	349	410	85.1
4	Female	53.0	1981	65	526	591	89.0
5	Female	44.2	1059	88	284	372	76.3
6	Female	43.1	1072	60	237	297	79.8
7	Male	49.7	1503	51	562	613	91.7
8	Female	36.5	584	36	206	242	85.1
9	Female	52.4	1796	44	424	468	90.6
10	Female	66.0	2980	43	651	694	93.8

Quality Assurance

Mercury Quality Assurance Program Sample Number		Our Results	
#2B	490 ± 60 µg/kg	544 ± 10	µg/kg
#2A	340 ± 40 µg/kg	372 ± 20	µg/kg

APPENDIX XV. MERCURY (µg/kg, ppb) IN FISH FROM LAC STE. ANNE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	55.8	2559	56	97	153	63
2	Female	58.1	1810	36	54	90	60
3	Male	54.3	1344	50	100	150	66
4	Female	60.1	1896	67	75	142	53
5	Female	54.2	1461	22	64	86	74
6	Male	43.0	702	135	46	181	25
7	*			33	283	316	90
8	*			62	64	126	51
9	*			84	166	250	66
10	*			51	38	89	43

* Heads only

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-B	Our Results
490 ± 60 µg/kg	410 ± 10 µg/kg

APPENDIX XV. MERCURY (µg/kg, ppb) IN FISH FROM LAC STE. ANNE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	44.4	1333	78.5	-	72	-
2	Female	59.9	2199	34	66	99.5	65.8
3	Female	45.5	1153	41	10.5	51.5	20.4
4	Female	40.5	803	34	13	47	27.6
5	*	-	-	60.5	74	135	54.8
6	*	-	-	60	73	133	54.9
7	*	-	-	32	75	107	70.1
8	*	-	-	46	125	171	73.1

* Head only

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-D	Our Results
1210 ± 140 µg/kg	1190 ± 130 µg/kg

APPENDIX XVI. MERCURY (µg/kg, ppb) IN FISH FROM LAKE ATHABASCA.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	62.3	1704	100	207	307	67
2	Male	50.6	1015	63	188	251	75
3	Male	61.6	1933	101	240	341	70
4	Male	47.0	854	35	131	166	79
5	Male	54.3	1241	50	164	214	77
6	Male	55.0	1045	27	293	320	92
7	Male	65.0	2052	104	270	374	72
8	Male	71.2	2864	83	217	300	72
9	Male	70.2	3141	54	243	297	82
10	Male	77.6	4152	76	237	313	76

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-B	Our Results
500 ± 40 µg/kg	450 ± 90 µg/kg

APPENDIX XVII. MERCURY (µg/kg, ppb) IN FISH FROM MOOSE LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	65.1	2156	108	379	487	78
2	Male	49.0	839	55	279	334	83
3	Female	47.3	794	32	61	93	66
4	Female	33.5	421	147	61	208	29
5	Female	52.9	1126	48	147	195	75
6	Female	75.8	3821	80	328	408	80
7	Female	62.3	1804	113	380	493	77
8	Female	52.3	974	121	149	270	55
9	Female	50.1	1043	50	124	174	71
10	Female	49.8	940	32	122	154	79

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-A	Our Results
340 ± 40 µg/kg	390 ± 50 µg/kg

APPENDIX XVII. MERCURY (µg/kg, ppb) IN FISH FROM MOOSE LAKE.

SPECIES: Walleye

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	43.6	1012	47	200	247	80.9
2	Male	33.8	472	39	152	191	79.6
3	Unknown	30.7	340	52	102	154	66.2
4	Female	44.1	1051	15	197	212	92.9
5	Male	47.5	1208	47	466	513	90.8
6	Male	32.5	396	92	102	194	52.6
7	Female	54.4	1918	50	568	618	96.9
8	Female	55.8	1893	115	565	680	83.1
9	Male	42.4	925	16	356	372	95.7
10	Female	55.1	1886	32	752	784	95.9
11	Unknown	35.0	739	25	245	270	90.5

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-B	Our Results
500 ± 10 µg/kg	490 ± 60 µg/kg

APPENDIX XVIII. MERCURY (µg/kg, ppb) IN FISH FROM MURIEL LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	47.8	886	92	231	323	71
2	Male	41.5	700	54	169	223	76
3	Male	44.4	805	77	83	160	52
4	Male	42.5	757	68	100	168	59
5	Male	84.0	4592	117	433	550	79
6	Male	70.9	3180	131	123	254	48
7	Male	72.5	4173	179	453	632	72
8	Male	72.4	3755	115	439	554	79
9	Male	79.0	4808	58	381	439	87
10	Male	35.7	364	101	219	320	69
11	Female	69.2	2966	92	247	339	73
12	Female	55.4	1486	68	272	340	80

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-D	Our Results
1190 ± 130 µg/kg	1460 ± 20 µg/kg

PPENDIX XVIII. MERCURY (µg/kg, ppb) IN FISH FROM MURIEL LAKE.

PECIES: White Sucker

ample umber	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	41.6	1134	72	175	247	71
2	Female	44.6	1241	63	91	154	59
3	Female	46.8	1567	91	150	241	62
4	Female	45.5	1395	72	76	148	52
5	Female	42.6	1128	106	91	197	46

APPENDIX XIX. MERCURY (µg/kg, ppb) IN FISH FROM MUSKWA LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	55.7	1298	47	337	384	88
2	Male	44.1	981	70	154	224	69
3	Female	57.8	1642	78	326	404	81
4	Female	56.0	1489	129	91	220	41
5	Female	56.6	1540	71	335	406	83
6	Female	58.0	1500	114	140	254	55
7	Female	55.1	1334	68	172	240	72
8	Female	90.0	6870	81	785	866	91
9	Female	82.4	5119	128	774	902	86
10	Female	81.3	5673	105	605	710	85

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-D	Our Results
1190 ± 130 µg/kg	1210 ± 20 µg/kg

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Brown Trout
LOCATION: Rocky Mountain House

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	15.8	52	-	-	32	-
2	Female	16.7	63	37	13	50	26.1
3	Male	17.7	74	30	24	54	44.2
4	Female	18.9	95	28	33	62	54.4
5	Female	24.7	184	44	27	72	38.4
6	Female	24.8	187	45	36	82	44.2
7	Female	25.3	203	28	131	159	82.3
8	Male	26.0	230	27	105	133	79.1
9	Female	31.2	390	42	75	117	63.6
10	Female	31.3	398	25	83	108	76.8
SPECIES: Walleye LOCATION: Rocky Mountain House							
1	Male	47.9	1430	48	636	684	92.9

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Whitefish
LOCATION: Rocky Mountain House

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	31.3	420	51	291	343	85.0
2	Female	34.5	550	27	56	84	67.2
3	Female	33.5	520	37	86	123	69.7
4	Female	34.1	440	27	99	126	78.6
5	Male	34.4	510	23	74	97	76.3
6	Female	35.3	550	31	87	119	73.5
7	Female	35.5	560	33	142	176	80.9
8	Female	35.7	550	34	70	105	67.2
9	Female	38.9	690	34	147	182	81.2
10	Female	39.0	820	39	68	108	63.6
SPECIES:	Sauger						
1	Female	36.3	580	43	322	365	88.2

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Walleye
LOCATION: Drayton Valley

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	37.5	550	23.5	255	279	91.6
2	Male	37.3	580	22.4	205	227	90.2
3	Male	39.4	780	14.8	222	237	93.7
4	Male	39.5	630	10.8	613	624	98.3
5	Male	42.0	920	22.4	383	406	94.5
6	Male	42.6	1050	15.7	425	440	96.4
7	Female	49.8	1530	29.5	403	432	93.2
8	Female	52.6	1670	23.0	283	306	92.4

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Sauger
LOCATION: Drayton Valley

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	29.9	300	82	205	288	71.3
2	Male	31.6	370	39	197	236	83.3
3	Female	31.8	380	58	204	262	77.8
4	Male	34.0	470	72	493	565	87.2
SPECIES: Goldeye LOCATION: Drayton Valley							
1	Male	32.3	430	29	376	405	92.8
2	Male	32.5	490	30	265	295	89.7
3	Male	33.4	470	25	303	329	92.1
4	Male	33.6	490	32	600	632	94.9
5	Male	34.1	420	43	405	449	90.2
6	Male	34.5	510	26	530	557	95.2
7	Female	35.0	-	40	378	418	90.5
8	Female	35.3	590	15	445	460	96.7
9	Female	36.4	620	43	407	451	90.3
10	Female	38.9	620	28	494	523	94.6

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Northern Pike
LOCATION: Drayton Valley

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	32.9	420	27	115	142	80.8
2	Male	34.6	310	29	144	174	82.9
3	Male	35.2	280	12	146	158	92.0
4	Female	35.4	320	35	105	140	75.0
5	Male	36.3	350	30	167	197	84.6
6	Male	41.4	570	12	116	129	90.3
SPECIES: Goldeye LOCATION: Genesee							
1	Male	23.0	430	33	753	786	95.8
2	Male	32.5	380	77	267	345	77.6
3	Male	33.7	500	62	320	383	83.6
4	Male	33.9	450	38	308	346	89.0
5	Female	33.9	450	22	347	370	94.0
6	Female	34.0	460	64	780	845	92.3
7	Male	34.4	450	37	340	377	90.0
8	Female	34.5	540	41	496	538	92.2
9	Female	34.7	550	32	399	432	92.4
SPECIES: Walleye LOCATION: Genesee							
1	Male	39.5	680	48	706	754	93.5

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Northern Pike
LOCATION: Genesee

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	35.1	280	30	128	159	80.7
SPECIES:	Walleye						
LOCATION:	Devon						
1	Male	40.7	830	16	627	644	97.5
2	Male	40.8	830	36	545	581	93.8
3	Female	44.0	900	25	862	887	97.1
4	Female	44.4	1150	37	236	274	86.2
SPECIES:	Sauger						
LOCATION:	Devon						
1	Female	37.1	610	34	582	617	94.4
2	Female	38.4	600	30	731	761	95.9

APPENDIX XX. MERCURY (µg/kg, ppb) IN FISH FROM THE NORTH SASKATCHEWAN RIVER.

SPECIES: Goldeye
LOCATION: Devon

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	30.6	410	43	113	157	72.3
2	Male	31.7	400	31	131	163	80.6
3	Male	32.8	560	46	492	538	91.4
4	Male	33.6	470	33	374	408	91.8
5	Male	33.8	530	50	300	351	85.6
6	Female	34.6	590	4	367	372	98.7
7	Male	35.7	740	27	272	299	90.8
8	Female	35.9	640	19	418	438	95.5
9	Female	36.3	840	33	466.5	500	93.3
10	Female	38.0	720	49	464	513	90.4

APPENDIX XXI. MERCURY (µg/kg, ppb) IN FISH FROM PINE LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	49.6	1123	41	131	173	76
2	Female	46.0	800	92	168	260	65
3	Female	47.8	958	70	116	186	62
4	Male	46.4	802	93	60	153	40
5	Female	82.0	5204	84	376	460	82
6	Female	75.1	3731	68	354	422	84

Quality Assurance

Mercury Quality Assurance Program Sample Number 2-D	Our Results
1190 ± 130 µg/kg	1230 ± 80 µg/kg

APPENDIX XXII. MERCURY (µg/kg, ppb) IN FISH FROM ROUND LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	66.6	2417	85	126	211	60
2	Female	62.7	1832	95	40	135	30
3	Female	70.2	3257	95	48	211	23
4	Male	46.5	728	65	51	116	44
5	Female	59.6	1353	62	55	117	47
6	Female	58.1	1257	83	237	320	74
7	Female	73.6	3463	53	205	258	79
8	Female	71.5	3743	76	374	450	83
9	Female	70.0	2885	75	178	253	70
10	Female	69.5	2676	31	186	217	86
SPECIES:	Walleye						
1	Female	51.4	1884	63	190	253	75
2	Female	51.4	1762	70	56	126	44
3	Female	48.9	1460	27	71	98	72
4	Male	44.0	1433	54	139	193	72
5	Female	28.2	241	43	208	251	83

Quality Assurance

	Mercury Quality Assurance Program Sample Number	Our Results
2A	340 ± 40 µg/kg	380 ± 0 µg/kg
2D	1190 ± 130 µg/kg	1230 ± 80 µg/kg

APPENDIX XXIII. MERCURY (µg/kg, ppb) IN FISH FROM THE SMOKY RIVER.

SPECIES: Longnose Sucker
LOCATION: Watino Crossing

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Immature	20.7	116	-	-	59	-
2	Female	42.4	970	31	343	374	91.5
3	Female	41.8	964	68	406	475	85.5
4	Female	42.4	937	49	288	337	85.3
5	Male	35.2	594	39	92	131	69.8
6	Female	37.9	684	38	127	166	76.7
7	Male	34.1	498	45	140	186	75.5

Quality Assurance

Mercury Quality Assurance Program Sample Number		Our Results
#132	490 ± 40 µg/kg	490 ± 50 µg/kg
#133	200 ± 30 µg/kg	200 ± 20 µg/kg
#134	890 ± 90 µg/kg	820 ± 40 µg/kg
#135	400 ± 30 µg/kg	440 ± 30 µg/kg

APPENDIX XXIII. MERCURY (µg/kg, ppb) IN FISH FROM THE SMOKY RIVER.

SPECIES: Longnose Sucker
LOCATION: Upstream of Wapiti River

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	32.1	431	37	132	170	78.0
2	Female	36.2	555	33	132	165	80.0
SPECIES:	Longnose Sucker						
LOCATION:	Benzanson						
1	Female	35.3	566	35	66	102	65.1
2	Female	26.6	227	37	338	376	90.0
3	Male	40.7	815	53	253	307	82.4
4	Male	34.2	528	26	176	202	87.1
5	Female	39.0	656	39	127	167	76.4
6	Female	42.9	952	35	300	336	89.3
7	Female	36.0	630	26	95	121	78.1
SPECIES:	White Sucker						
LOCATION:	Benzanson						
1	Male	47.31	1342	28	195	224	87.2
SPECIES:	Northern Pike						
1	Male	40.0	397	31	96	128	75.4

APPENDIX XXIV. MERCURY (µg/kg, ppb) IN FISH FROM THE WAPITI RIVER.

SPECIES: Longnose Sucker
LOCATION: Wembley

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Male	41.0	750	28	432	461	93.8
2	Female	40.3	762	27	585	612	95.6
3	Immature	31.3	348	33	141	175	80.8
4	Female	40.4	869	28	455	483	94.0
5	Male	36.1	569	26	242	268	90.3
6	Male	29.9	283	37	128	165	77.4
7	Male	37.6	672	42	447	490	91.3
8	Immature	34.1	472	25	175	201	87.2
9	Female	39.9	752	31	260	292	89.2
10	Male	36.2	665	35	224	280	87.3
SPECIES: Northern Pike							
1	Female	75.9	4247	34	635	670	94.8
SPECIES: Rocky Mountain Whitefish							
1	Male	27.3	223	64	27	91	30.1

APPENDIX XXIV. MERCURY (µg/kg, ppb) IN FISH FROM THE WAPITI RIVER.

SPECIES: Longnose Sucker
LOCATION: Northern Alberta Railway Bridge

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	34.6	494	38	40	79	51.6
2	Immature	32.8	404	20	122	143	85.5
3	Male	34.8	500	25	92	118	78.2
4	Male	37.2	581	35	155	191	81.4
5	Male	43.9	877	35	145	181	80.3
6	Female	39.1	764	37	255	293	87.2
7	Male	35.4	543	32	151	184	82.4
SPECIES: Rocky Mountain Whitefish							
1	Male	30.7	289	31	108	139	77.2
2	Male	18.5	71	39	38	77	49.2
SPECIES: White Sucker							
1	Female	44.1	1042	40	248	289	85.9

APPENDIX XXIV. MERCURY (µg/kg, ppb) IN FISH FROM WHITEFISH LAKE.

SPECIES: Northern Pike

Sample Number	Sex	Length (cm)	Weight (g)	Inorganic Hg	Methyl Hg	Total Hg	% Methyl Hg
1	Female	70.5	3030	44	288	332	87
2	Female	60.4	1715	15	236	251	94
3	Male	60.4	1932	18	356	374	95
4	Male	54.5	1333	17	269	286	94
5	Male	61.1	1948	20	339	359	95
6	Female	62.5	1844	23	440	463	95
7	Female	66.1	2479	25	230	255	90
8	Male	57.5	2018	14	376	390	96
9	Male	40.0	856	24	209	233	90
10	Female	63.6	2059	20	245	265	93

SPECIES: Walleye

1	Male	38.8	711	67	205	272	75
2	Female	40.7	889	54	184	238	78
3	Female	41.6	893	44	233	277	84
4	Female	38.6	722	27	213	240	89
5	Male	40.3	837	29	232	261	89
6	Male	38.2	703	35	285	320	89
7	Male	37.0	651	136	263	399	66
8	Male	35.0	547	115	201	316	64
9	Male	49.0	1307	57	599	656	91

Quality Assurance

Mercury Quality Assurance Program Sample Number 150	Our Results
790 ± 50 µg/kg	700 ± 70 µg/kg

APPENDIX XXVI. LIST OF FISH SPECIES COLLECTED DURING THIS STUDY.

COMMON NAME	SCIENTIFIC NAME
Northern Pike	*Esox lucius*
Goldeye	*Hiodon alosoides*
White Sucker	*Catastomus commersoni*
Flathead Chub	*Ptatygobio gracilis*
Longnose Sucker	*Catostomus catostomus*
Walleye	*Stizostedion vitreum*
Arctic Grayling	*Thymallus arcticus*
Rocky Mountain Whitefish	*Prosopium williamsoni*
Lake Whitefish	*Coregonus clupeaformis*
Burbot	*Lota lota*
Brown Trout	*Salmo trutta*
Rainbow Trout	*Salmo gairdnerii*